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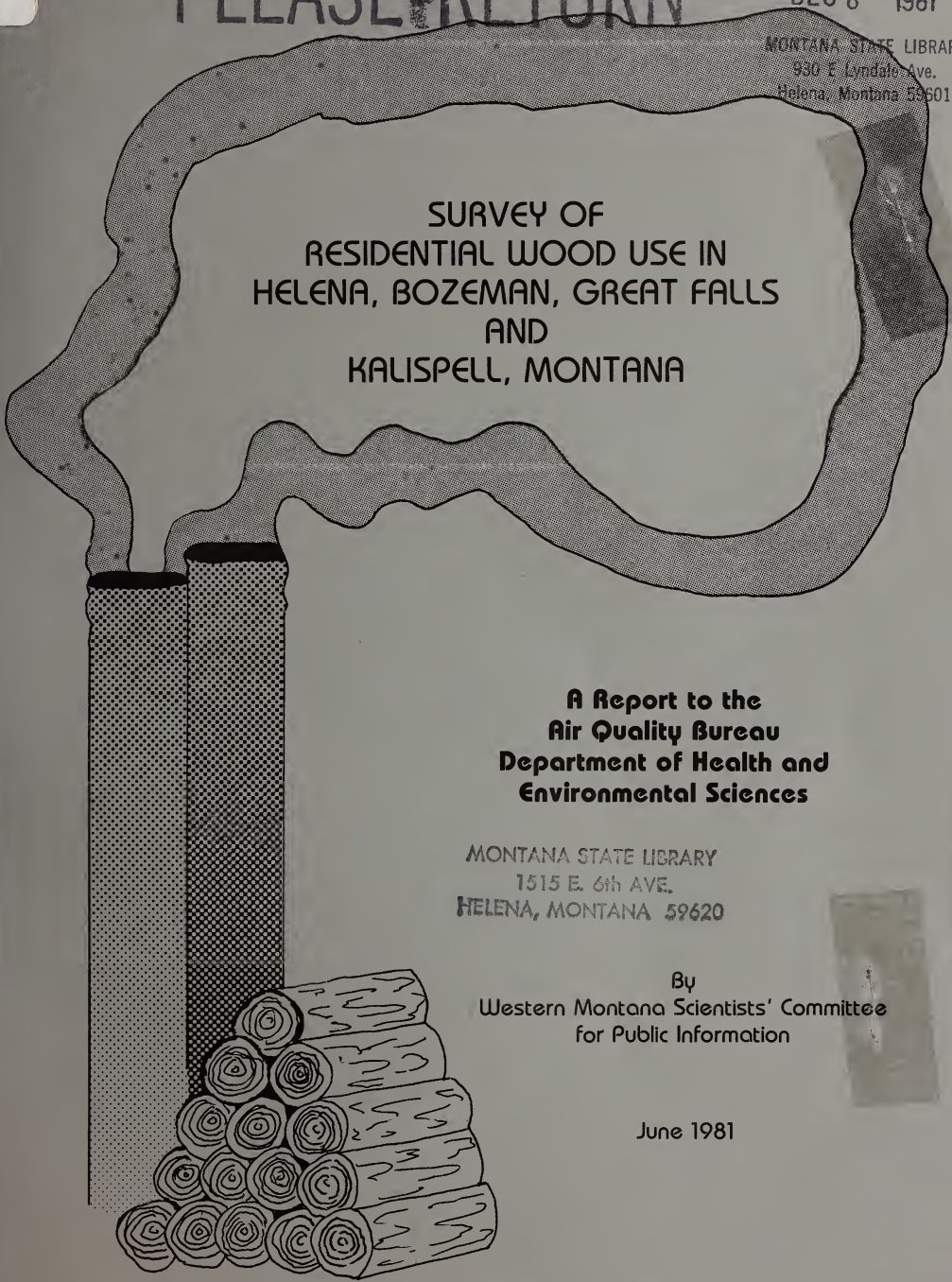

A Report to the Air Quality Bureau Department of Health and Environmental Sciences

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Survey of residential wood use in Helena
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SURVEY OF RESIDENTIAL WOOD USE IN HELENA, BOZEMAN, GREAT FALLS & KALISPELL, MONTANA:

A Report to the Montana Department of Health & Environmental Sciences, Air Quality Bureau

by Western Montana Scientists' Committee for Public Information

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June, 1981

ABSTRACT

A survey of woodburning was conducted during the winter of 1981 in four cities in Montana in an attempt to determine how much wood was being burned and what quantities of carbon monoxide and particulates were being emitted. Results from the sample population were broken down by census divisions within each city, and projected onto the total city population.

Pertinent emission studies were reviewed and emission factors and pollutant mass rates adopted for each type of common woodburning device. Then using those values, two methods of estimating emissions were developed. These were based on on the respondents' estimates of: 1) the amount of wood burned during the winter, and 2) the number of hours each type of woodburning device was operated. Data was analyzed using both methods of estimation to derive the contribution of each type device to total wood consumption and total emission outputs.

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ERRATA

RE: Survey of Residential Wood Use in Helena, Bozeman, Great Falls and Kalispell, Montana: A Report to the Montana Department of Health and Environmental Sciences, Air Quality Bureau, Missoula, Montana, Western Montana Scientists' Committee for Public Information, 104 pgs., June, 1981.

Part V: Emission Factors

Page 16, line 25, delete "CO_2" and insert "CO"

Page 19, Table 3b. A corrected page 19, Table 3b is attached. Please delete the original page 19 and replace it with the corrected page 19 enclosed.

Part VI: Preliminary Computations

Page 45, Table 14, last line, delete "Note: N = 413" and insert "Note: N = 431"

TABLE 3b

Burning Conditions and Emission Factors
for Residential Wood Stoves [a]

Reference	Wood Type	% Moisture	Burn Rate (lb/hr)	Particulate Pollutant Mass Rate (lbs/hr)[b]	Particulate Emission Factor (lbs/ton)	CO Pollutant Mass Rate (lbs/hr)[b]	CO Emission Factor (lbs/ton)
DeAngelis, et al.[m] 1980	Yellow Pine	5.16	15.87	.1714	16.	4.2858	540
	"	"	15.87	.1206	15.2	2.381	300
	"	29.61	13.23	.2513	38.0	2.910	440
	"	"	17.20	.3336	32.8	1.668	194
Butcher & Sorenson[n] 1979	Pine	42.4	4.589	.0476	20.74		
	"	"	5.086	.0549	21.58		
	"	"	2.768	.0513	37.04		
	"	"	2.176	.0334	30.66		
	"	"	4.198	.0403	19.2		
	"	"	7.532	.0999	26.52		
Rossman & Odell[p] 1980	Douglas Fir	14.	8.264	.1975	47.8		
	"	"	3.643	.1844	101.2		
	"	"	7.952	.1852	46.6		
	"	"	3.265	.2436	149.2		
OMNI 1981[q]	Douglas Fir	35.9	10.311	.1938	37.6		
	"	"	12.699	.1270	20.		
	"	19.4	9.896	.3078	62.2		
	"	17.1	9.896	.1979	40.0		
EPA							260
WMSCPI	Western Larch[6]	25[g]	11.699[r]	.2925[j]	50[k]	1.515[j]	260[k]
	Lodgepole Pine		3.675[s]	.1838[j]	100[k]	.8098[j]	440[k]
			29.85[t]	.1089	7.3	.4478	34

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INTRODUCTION

In the fall of 1980, the Air Quality Bureau of the Montana Department of Health and Environmental Sciences contracted with the Western Montana Scientist's Committee for Public Information (WMSCPI) to conduct a survey of wood burning and potential air pollutant emissions in four cities in Montana. This report is a summary of that survey conducted during the winter (January-March) of 1981.

This work has been roughly patterned after an earlier, similar study by Otis conducted in Missoula, Montana, in 1978, and has adopted several of the Otis computational schemes. These instances are noted in the text, but should not be construed to extend liability for this work beyond the present authors, who assume full responsibility for its content and conclusions.

In some instances, new analytical techniques have been developed. These techniques and the reasons for their adoption are explained.

The authors wish to acknowledge the assistance of Scott Church of the Missoula City County Department of Health who aided in development of several computations and in the choice of several key values.

Finally, we gratefully acknowledge the monumental efforts of Robert Boldi at the computer and of William Tomlinson at the helm, without whose invaluable energies this project could not have happened.

METHODS

I. Preliminary Research

The project began with a review of pertinent literature to ascertain what parameters affecting emission outputs the survey questionnaire should attempt to assess. Studies on the emission testing of wood burning devices were examined along with other documents relating to important variables, such as fuel moisture content. As a result, certain critical variables were identified. These included: air supply (i.e. amount, velocity and location of inlet), quantity of fuel charge, quality of fuel (i.e. moisture content and heat potential), geometry of the fuel (i.e. surface to volume ratio and shape of fuel) and the size and shape of the combustion chamber.

Unfortunately, most of these variables were too complicated to be assessed meaningfully by a study of this scale. Consequently, only the most obvious parameters were chosen for evaluation; these being the particular wood burning device, the amount of time it is used, the manipulation of the air supply, and how much wood is being burned. Other parameters were cursorily addressed to examine common practices among wood burners (e.g. wood storage practices). These are quantified in the report for information purposes only and were not used in the computation of pollutant outputs.

II. The Questionnaire

The questionnaire was divided into six basic categories of questions and information. (See Table 1)

1) {Questions 1 & 2} Administrative information for handling purposes; this included information on location and type of contact. Ques-

TABLE 1

Questionnaire # _____
Interviewer _____
Interview Technique _____
Census Tract _____

RESIDENTIAL WOOD COMBUSTION SURVEY
GREAT FALLS, KALISPELL, HELENA, AND BOZEMAN, MONTANA

1. In which city is your residence located? 1) Great Falls 2) Kalispell 3) Helena 4) Bozeman

2. What is the address of your residence? _____

3. Do you burn wood in your residence or garage? 1) Yes 2) No

4. Do you burn wood mainly for: 1) Primary Heat 2) Auxiliary Heat 3) Cooking 4) Enjoyment

5. Do you have a fireplace? 1) Yes 2) No
   How many? _____
   Days/week burned? 1 2 3 4 5 6 7
   Hours/day burned? _____
   Does your fireplace have doors that regulate burning? 1) Yes 2) No

6. Do you have an airtight wood stove? 1) Yes 2) No
   How many? _____
   Days/week burned? 1 2 3 4 5 6 7
   Hours/day burned? _____

7. Do you have a non-airtight woodstove? 1) Yes 2) No
   How many? _____
   Days/week burned? 1 2 3 4 5 6 7
   Hours/day burned? _____

8. Do you have a wood furnace? 1) Yes 2) No
   Days/week burned? 1 2 3 4 5 6 7
   Hours/day burned? _____

9. Do you have a cookstove? 1) Yes 2) No
   Days/week burned? 1 2 3 4 5 6 7
   Hours/day burned? _____

10. After a fire has been established in your woodstove do you fully close the draft? 1) Yes 2) No

11. How much wood do you expect to burn this winter?
    Number of cords (4'x 4'x 8' stack) _____
    If uncertain about the number of cords how many pickup loads? _____
    What size is the pickup truck? 1) Small 2) Medium 3) Large

12. How much of the wood that you will burn this year has been dead for at least 6 months? 1) Less than 40% 2) 40 - 80% 3) 80 - 100%

13. Is the wood that you are burning this winter covered? 1) Yes 2) No

14. Is the wood that you have stored for burning this winter split or have a diameter of less than 6 inches? 1) Yes 2) No

15. If the wood is unsplit is it in lengths longer than three feet? 1) Yes 2) No

16. Do you intend to install any wood burning equipment in the next two years? 1) Yes, definitely 2) 50/50 chance 3) No

17. What type(s) of wood burning equipment would you probably install?
    1) Fireplace 2) Airtight wood stove 3) Non-airtight wood stove
    4) Wood Furnace 5) Cookstove

FOR ADMINISTRATIVE PURPOSES ONLY

COMMENTS:

tionnaires were also color coded for ease in handling.

2) {Questions 3-8} Do you burn wood, if so why; in what kind of equipment, and how often for how long?

3) {Question 10} If you use a wood stove, do you usually close the draft once the fire is established?

4) {Question 11} How much wood do you expect to burn this winter (in terms of cords or pickup truck loads)?

5) {Questions 12-15} How old is your wood and how is it stored?

6) {Questions 16 & 17} Future plans as regards wood burning devices.

III. Sample Selection

A sample was selected from the Polk City directory for each of the four cities. The sample size was determined by analysis of the earlier Otis study and the actual mechanics of the selection were accomplished by the methods explained in Appendix A. The sample sizes eventually surveyed were adequate to produce results within the specified range of error of 10%. (See Appendix A)

IV. Interview Technique

Households chosen for contact were contacted in one of three ways: 1) telephone, 2) mail, 3) personal contact. In addition, a fourth method was used to generate information from housing units identical to that of a selected unit. For example, if the occupant of a particular selected apartment could not be contacted, in a few cases a neighbor was asked about conditions in that building. If it was clear that the information applied to the selected unit, it was used for the survey. (See Table 2)

Telephone Contact

During the course of the telephone part of the survey, five interviewers were employed to call the selected sample on five evenings a week and weekend

afternoons and evenings. Three attempts were made to contact each household with a phone at three different times of the week. After three unsuccessful attempts a phone number was considered a "miss" and was designated for contact by mail.

The actual telephone technique involved the interviewer identifying him/herself and the nature of the survey. The address was then verified. If the respondent did not burn wood, only the last two questions on future plans were asked. If the respondent did burn wood, the rest of the questionnaire was completed (or at least attempted). Most of the survey was conducted by phone. (See Table 2)

Mail Contact

This second phase of the survey was conducted after all people contactable by phone had been reached. Copies of the questionnaire and an explanatory cover letter (See Appendix B) were mailed to all households in the sample of each city that had not been successfully contacted by phone. This included: people who had refused to participate by phone; people without telephones, and anyone with a phone that had not been reached. Attempted mail contact, therefore, amounted to a large percentage of the sample of each city (no specific values are available). Return of mailed questionnaires was quite high (about 43%) and the percentage of each sample contacted in this manner ranged from 12 to 25%. (See Table 2)

Personal Contact

Any household not reached successfully by phone or mail was scheduled for personal contact. (This list excluded some people who had refused to participate with untempered vehemence. It also did not include addresses

Table 2

Summary of Interview Results and Techniques

City	Total Response (#)	Telephone (#)	Telephone (%)	Mail (#)	Mail (%)	Visit (#)	Visit (%)	Other (#)	Other (%)	Misses[a] (#)	Misses[b] (%)	Refused (#)	Refused[c] (%)
Bozeman	417	275	65.95	76	18.23	66	15.8	0	0	27	6.0	6	1.42
Great Falls	415	275	66.26	53	12.77	77	18.55	10	2.4	27	6.0	8	1.89
Helena	431	311	72.2	50	11.6	68	15.8	2	.46	15	3.33	4	0.92
Kalispell	406	223	54.9	97	23.9	86	21.2	0	0	34	7.56	10	2.4

a. Misses resulted from: mistakes in the Polk Directory, mistakes in questionnaire handling, no contact (see appendix A)
b. % misses is the percent of the original sample of 450 not contacted
c. % refusal based on the sample size remaining after "misses" were subtracted (e.g. Bozeman, 6/450-27)

that were incorrect as listed in the Polk Directory. (See Appendix A) Teams of 2-3 interviewers went to each city to attempt contact with the sample households. At least two attempts were made at each address. Success rates were relatively high. (See Table 2)

In some cases where residences could not be contacted, assessment was made by other means. This included talking to neighbors in identical housing units (i.e. apartments) and/or visual assessment of the presence or lack of a WBD roof vent, wood pile, etc. In one instance in which an interviewer was refused information and almost physically ejected from the premises, an assessment was made based on the brief viewing of the situation in the house.

In all cases where no successful contact was made and where no definite assessment was possible, that sample was declared a "miss" and not included in the remainder of the study.

Census Information

Each city was divided into convenient "census" areas (Figures 1 , 2 , 3 , 4) for purposes of locating concentrations of wood burning within the greater urban area. These divisions were made at the discretion of the authors, based on existing census divisions, grouped to approximately equal sizes.

Each questionnaire was located by address and given a "census tract" designation. The census coding for each city is explained in detail in Appendix C.

Computer Encoding

Completed questionnaires were encoded by the number of the response to a particular question and the data was entered and stored in the Decsystem 20 for later analysis. A special program was developed to output the data

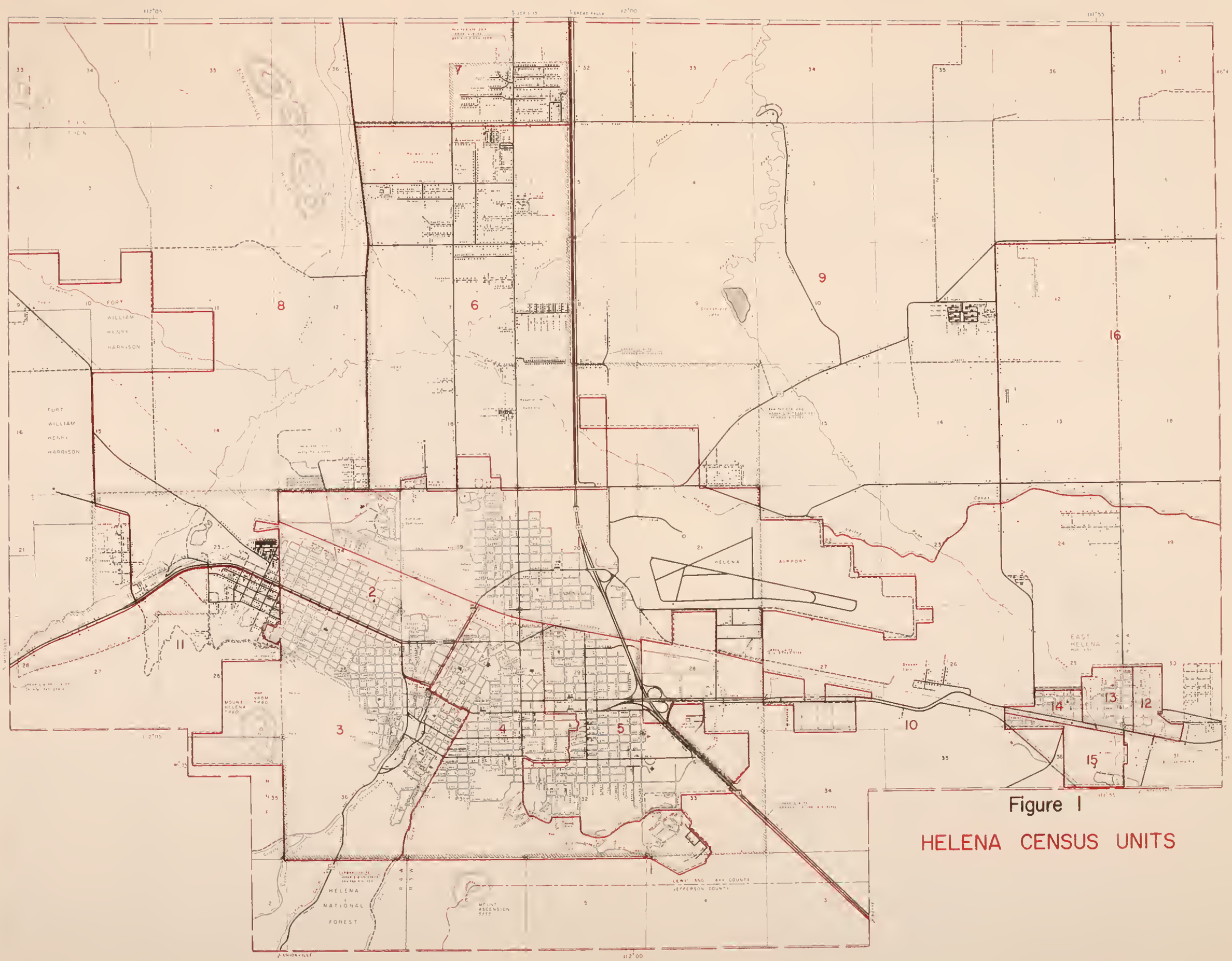

Figure 1

HELENA CENSUS UNITS

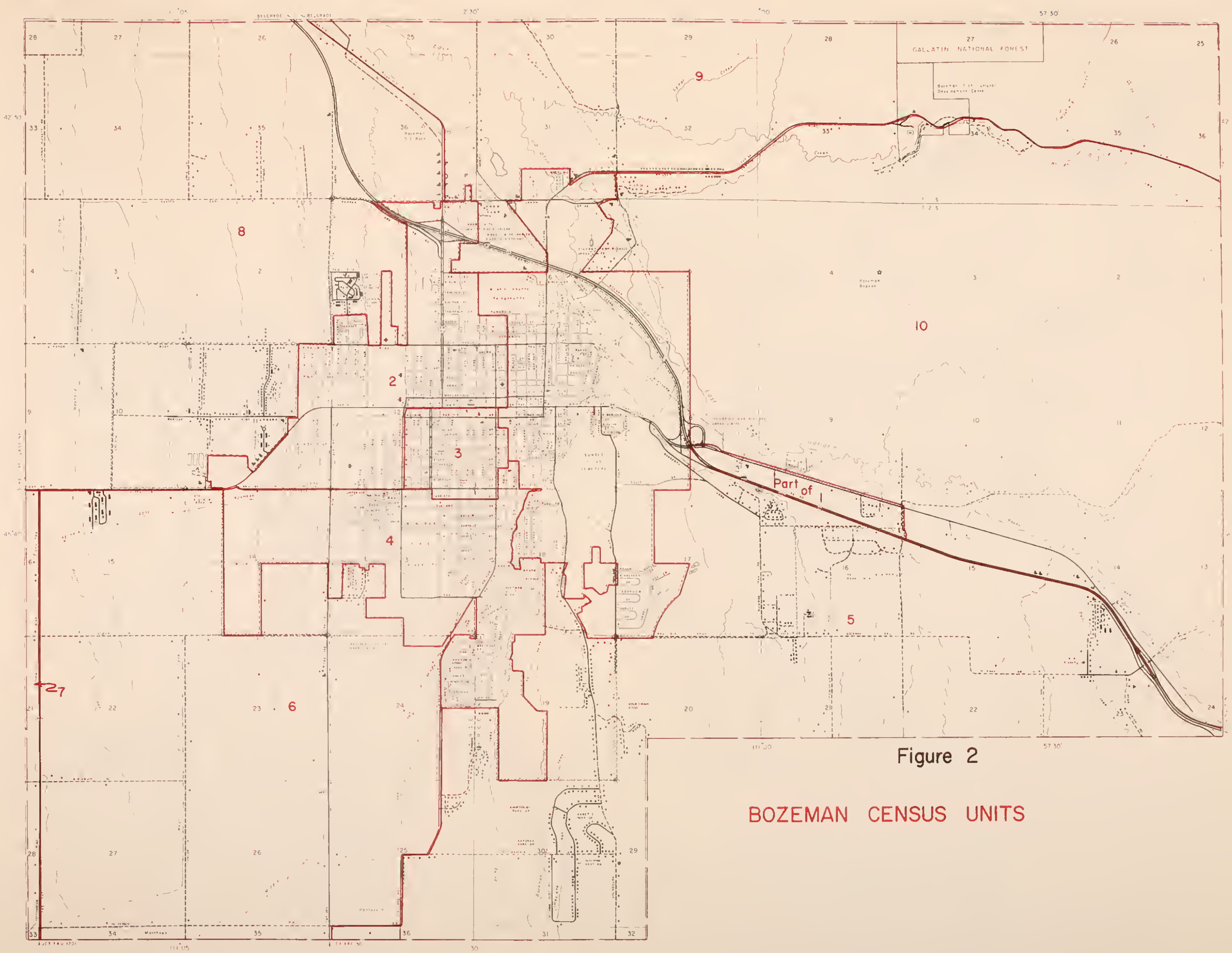

Figure 2

BOZEMAN CENSUS UNITS

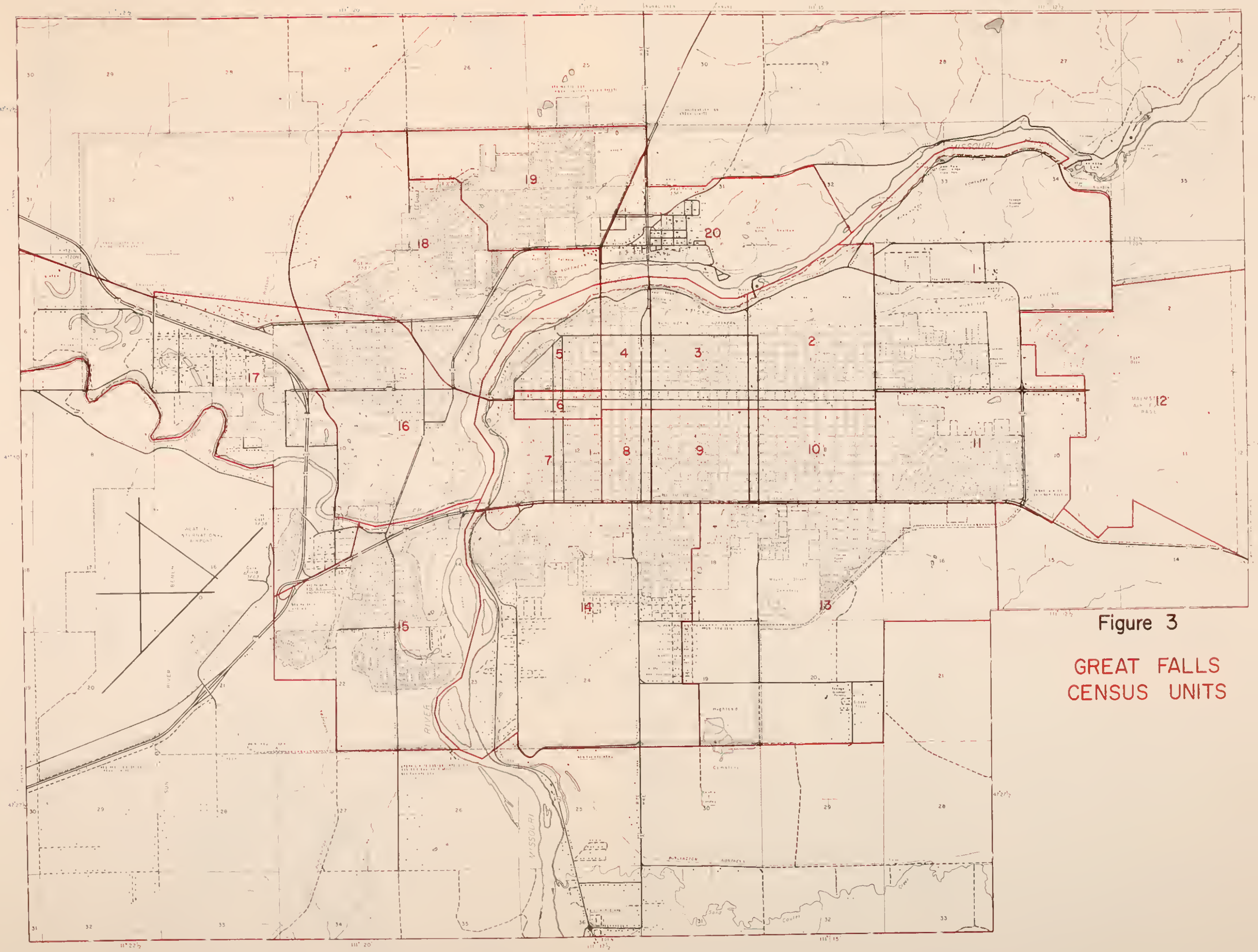

Figure 3

GREAT FALLS
CENSUS UNITS

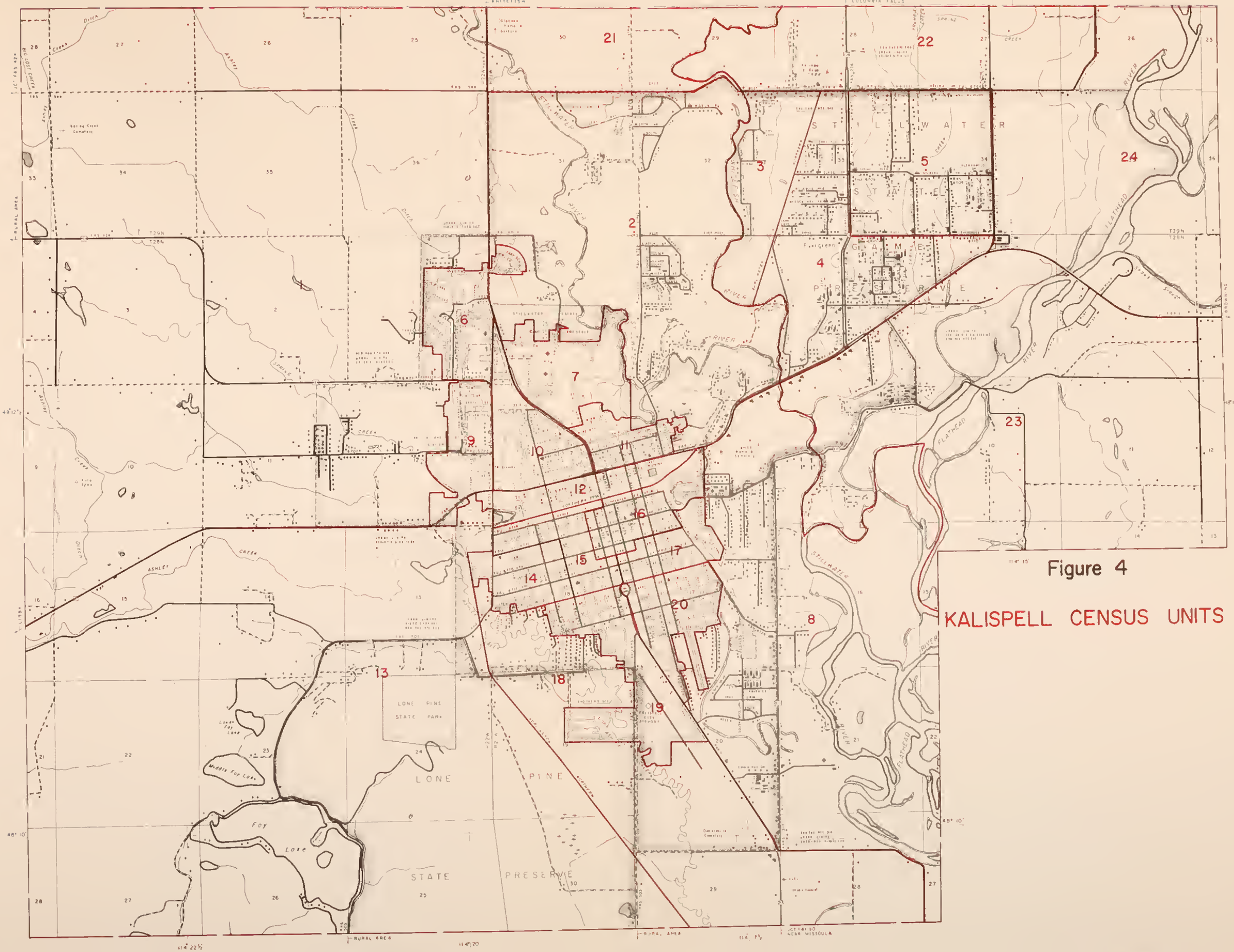

Figure 4

KALISPELL CENSUS UNITS

files in a form that was easily comparable to the original questionnaires. Each file was triple checked for accuracy before any further calculations were performed.

V. Emission Factors

The choice of emission factors (the amount of pollutants produced from burning a specified amount of wood) was a critical part of this study. Emission test studies of various wood burning devices have, for assorted reasons, specified a range of emission levels. (See Tables 3a and 3b) The choice of values for emission outputs was therefore made by examining the available literature, assessing the critical points of each study, and then adopting numbers thought to be representative of common burning practices.

Such an assessment hinged first upon how the parameters which most clearly affect emissions (as noted above) were manipulated and/or ignored in each study. Second, did a study reflect common burning practices, with the type and condition of fuels that are most probably used? Finally, what were the actual methods of emission testing and could they be compared? In the following section, the pertinent literature is briefly examined based on these points. (See Tables 3a and 3b)

The Studies - Emission Testing

Taking the last point first, all the following studies with the exception of Butcher and Sorenson's (1979) used the same technique for particulate emission testing. This was EPA method 5, modified with additional filters. This method uses a two section sampling train which captures both solid particulate and volatile condensibles by direct stack sampling. For specifics of this procedure, see any of the listed studies. The monitoring of CO_2 used

the methods specified in each study.

Fireplaces - Table 3a

Snowden, et al. (1975), source tested fireplaces using several types of wood. Only the fir and pine species are listed in the Table. Note that the moisture content of the wood tested is low, ranging from 42 to 61% of the value chosen for the present assessment (25% moisture), which is thought to be representative of woods burned in Montana.

Tests conducted in this study were begun from cold start up, but once a fire was established it was maintained (stoked and fueled) to prevent smoldering. Only one test was performed while the fire was smoldering. Consequently, this study represents only fireplaces burning extremely dry wood under optimum high fire conditions.

DeAngelis, et al. (1980) tested a fireplace using both extremely dry and probably wetter than average wood. These tests were conducted by adding the charge of test fuel to an established bed of coals and then managing the fire to maintain high fire and to prevent smolder. This represents only fireplaces operated in this manner and does not include cold start up.

PEDCo (1977) tested fireplaces using extremely dry wood. This may have actually increased the emission of particulates, since the "optimal" moisture content is about 22%, with emission rates rising for both drier and wetter woods. (See Allen, 1981, Figure 7) These tests measured emissions from the complete fire cycle: cold start up - stable - burn down. However, the fire was maintained to prevent smolder.

TABLE 3a

Burning Conditions and Emission Factors
for Residential Fireplaces [a]

Reference	Wood Type	% Moisture	Burn Rate (lb/hr)	Particulate		CO	
				Pollutant Mass Rate (lbs/hr)[b]	Emission Factor (lbs/ton)	Pollutant Mass Rate (lbs/hr)[b]	Emission Factor (lbs/ton)
Snowden, et al.[c] 1975	Douglas Fir	10.6	12.57	.1445	23.0		
	"	"	9.04	.1301	28.8		
	"	"	18.3	.1610	17.6		
	"	"	14.77	.1994	27.0		
	Western White Pine	15.4	24.69	.1778	14.4		
	"	"	30.86	.2006	13.0		
	"	"	24.47	.3328	27.2		
	"	"	20.06	.1625	16.2		
DeAngelis, et al.[d] 1980	Yellow Pine	5.16	25.13	.1935	15.4	.5277	42.0
	"	29.61	21.16	.2539	24.0	.3175	30.0
PEDCo[e] 1977	Pine	7.49	10.58	.2227	42.0	.4565	86.3
	"	"	18.08	.3003	33.2	.5026	55.6
	"	"	8.6	.0840	19.6	.8789	204.4
	"	"	7.05	.1470	41.6	.7381	209.4
	"	"	7.05	.1631	46.2	.7748	219.8
	"	7.7	7.94	.1761	44.4	.9933	250.2
	"	"	15.65	.3137	40	1.69	216.0
	"	"	10.58	.2053	38.8	1.221	230.8
	"	"	10.14	.2672	52.6	1.049	207.0
EPA					20		120
WMSCPI	Western Larch[f] Etc.	25[g]	15.62[h]	.2343[j]	30[k]	1.562[j]	200[k]

TABLE 3b

Burning Conditions and Emission Factors
for Residential Wood Stoves [a]

Reference	Wood Type	% Moisture	Burn Rate (lb/hr)	Particulate		CO	
				Pollutant Mass Rate (lbs/hr)[b]	Emission Factor (lbs/ton)	Pollutant Mass Rate (lbs/hr)[b]	Emission Factor (lbs/ton)
DeAngelis, et al.[m] 1980	Yellow Pine	5.16	15.87	.1714	21.6	4.2858	540
	"	"	15.87	.1206	15.2	2.381	300
	"	29.61	13.23	.2513	38.0	2.910	440
	"	"	17.20	.3336	38.8	1.668	194
Butcher & Sorenson[n] 1979	Pine	42.4	4.589	.0476	20.74		
	"	"	5.086	.0549	21.58		
	"	"	2.768	.0513	37.04		
	"	"	2.176	.0334	30.66		
	"	"	4.198	.0403	19.2		
	"	"	7.532	.0999	26.52		
Rossman & Odell[p] 1980	Douglas Fir	14.	8.264	.1975	47.8		
	"	"	3.643	.1844	50.6		
	"	"	7.952	.1852	46.6		
	"	"	3.265	.2436	149.2		
OMNI 1981[q]	Douglas Fir	35.9	10.311	.1938	37.6		
	"	"	12.699	.1270	20.		
	"	19.4	9.896	.3078	62.2		
	"	17.1	9.896	.1979	40.0		
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WMSCPI	Western Larch[f]	25[g]	11.699[r]	.2925[j]	50[k]	1.515[j]	260[k]
	Lodgepole Pine		3.675[s]	.1838[j]	100[k]	.8098[j]	440[k]
			29.85[t]	.1089	7.3	.4478	34

FOOTNOTES FOR TABLES 3a & 3b

a. Summary of available data derived from experimental studies. The numbers listed are as reported in the original studies, except where calculations are noted, and have been converted to standard units for the sake of comparison. The data shown in this table were chosen for their applicability to woods generally available in the pacific northwest (or similar woods).

b. Pollutant Mass Rate: In some studies this rate was measured directly, for all others it was calculated by WMSCPI for purposes of presentation here. That calculation was made as follows:

$$\frac{BR\ (\#/hr)}{2000(\#/ton)}\ x\ EF\ (\#ton) = PMR \text{ where,}$$

BR = Burn Rate given or calculated from available studies;
Division by 2000 converts the BR to tons/hour;
EF = the emission factor as measured from the studies;
PMR = Pollutant Mass Rate in terms of the pounds of pollutant generated per hour;
Note: In instances where the PMR was determined in the original study, the use of the above calculation generated comparable and consistently lower figures for the PMR.

c. This study used only dried wood burned under fast, stable conditions. Tests began from cold start up, but once the fire was established, efforts were made to maintain constant, high fire conditions. Only one test was made under smolder conditions.

d. Tests were made by adding the test charge of fuel to an established bed of coals and stoking to maintain high fire conditions.

e. This study was conducted using extremely dry wood which may have contributed to the higher rate of emissions. (See Allen, 1981, Figure 7) In addition, measurements were made during the entire burn cycle from cold start up-to stable-to burn down, but efforts were made to prevent smolder. This study may, therefore, more accurately reflect emission outputs from the full fire cycle, but still does not include smolder conditions.

f. Woods burned in the cities studied.

g. This number was chosen as a generally acceptable value for moisture content in consultation with personnel of the Missoula City County Department of Health Air Quality Unit, who are currently analyzing a similar study. This figure is presented in this table for information only and did not directly affect the calculations of emission rates.

h. This burn rate is the mean of the rates measured in the listed studies. Since the available studies did not assess burning rates under smolder conditions, this figure may be somewhat high, thereby elevating the calculation of the PMR which is based on this rate.

j. The PMR shown here is not based on the PMR's listed in the table which are presented for comparison. Instead, this figure is calculated based on the Burn Rate and the chosen Emission Factor.

k. These emission factors are not derived directly from the experimental data but are instead best estimates of the emission levels that probably result from real, field situations.

m. These tests on two airtight stoves used only stable burning conditions with the effects of smolder burning not taken into account.

n. This is the only study of all those listed that did not test emission rates using the usual, modified EPA Method 5. Instead, two airtight stoves were tested using a high volume sampler which may not have collected some of the condensable organics.

p. This study tested two airtight stoves under both high fire and low fire conditions. No smolder burning was conducted, but the entire burn cycle was monitored. Therefore, except for the relatively low moisture content of the wood burned, this study may more realistically reflect the field situation.

q. These tests were conducted on two airtight stoves under high fire conditions, but again, through the entire fire cycle.

r. The mean of high fire burn rates which was taken to be >6 pounds/hr.

s. The mean of low fire burn rates which was taken to be <6 pounds/hr.

t. The Burn Rate of a wood stick fired boiler.

Peters, et al. (1981) critiqued the PEDCo study in an attempt to explain the difference between it and the work by DeAngelis, et al. The main differences pointed out were the use of dry pine (a more resinous wood) and the fact that the PEDCo fuel burn quantification was based on visual estimates of the amount of fuel left unburned. If as Peters conjectures this estimate of remaining fuel is indeed "biased . . . toward the low side" it could inflate the emission factors. However, other studies on fireplaces not shown in the Table tend to support the PEDCo findings (Short, 1974; Hayden and Braaten, 1980). In addition, other studies on stoves discussed below tend to indicate that all the DeAngelis' factors may be low.

Several other studies were reviewed, but were not included in the Table because differences in analytical technique (i.e. non-Method 5), and differences in the type of wood burned prevent strict comparisons of results. It should be noted, however, that two studies, Short, 1974, and Hayden and Braaten, 1980, both sampled the full fire cycle. In spite of the fact that both used all or part hard wood for their testing (which Peters, 1981, says will produce lower emission levels), both studies found higher emission rates for fireplaces than did either Snowden or DeAngelis. Both these studies support the adoption of the WMSCPI estimates explained below. (See Appendix D for tables of these results.)

The values listed as EPA figures are the "accepted" values for emission factors from residential fireplaces. They are based only on the work of Snowden, et al., and are probably low due to the limited conditions tested.

Otis applied an emission factor of 25 pounds per ton based on the work of Snowden and then compensating upwards to account for differences in resin content and moisture content. Otis's factor, too, is thought to be low due to the limited conditions considered.

Fireplace Discussion

None of the available studies measured conditions of operation that are reflective of common use practices. Obviously, the field situation would include the entire fire cycle from cold start up to burn out. Common operation also probably includes at least some smolder burning since most people do not tend their fires closely. In addition, emissions may be higher because many people probably use wood with moisture content higher than that tested.

For the above reasons, WMSCPI adopted what it thought to be representative to conservative estimates of pollutant emission factors. For particulates, a rate of 30 pounds per ton of wood burned was adopted. This is the mean of the emission rates shown in Table 3a and is thought to be conservative since testing did not include smolder conditions which increase particulate output.

The value chosen for output of CO is 200 pounds per ton of wood burned. This is higher than the mean of available values (159.) and, although based on limited data and some speculation, is thought to be more representative of common firing practices which would include both full fire cycle and some smolder burning. It is also the value recommended for use by the PEDCo report.

Wood Stoves - Table 3b

DeAngelis, et al. also source tested two airtight wood stoves using the same basic techniques discussed above. Fuel was charged to an established bed of coals in a hot stove. This excludes the emissions of cold start up which contribute significantly to the total. Air supply was maintained to

prevent both excess air and smolder burning. Burn rates and resulting emissions are therefore most representative of "high fire" burning and not reflective of any smolder burning. Even so, emission rates from medium moisture wood are higher than the rate used by Otis.

Butcher and Sorenson burned relatively high moisture content wood at relatively low burn rates by keeping air supply fairly low. This should have generated high particulate emissions, but for some reason did not. WMSCPI presents the following suggestions for this apparent aberration. First, the tests were conducted using a high volume sampler collecting from the flue about 18 feet above the stove. The temperature at the collection point was not monitored but was estimated to be about 100°C. Assuming this estimate is accurate (it seems low), it is not unreasonable to assume that some of the condensible organics in the effluent would have still been gaseous at this temperature. The statements in the study notwithstanding, WMSCPI believes this may have reduced the collection of this portion of the effluent.

In addition to the above conditions, Butcher and Sorenson tested the stoves using relatively small charges of wood (3-9 lbs.). Fuel charge size is now known to contribute significantly to emission output, with emission rates varying inversely to the size of the fuel charge.[1] Burning a small charge reduces particulate production, and even though this may be desirable, it is probably not representative of common burning practices.

Two studies of stove emissions were recently completed in Oregon. For purposes of brevity and since they were conducted similarly, they will be discussed together. They are particularly important to this study because their results are taken to be the most representative of common burning conditions and practices of any study to date.

Rossman and Odell (1980) and OMNI (1981) tested particulate emission rates for seven different kinds of stove. This discussion, and the figures presented in Table 3b focus on the results stemming from four commonly available stoves. Fuel moisture content ranged from 14 to 36% and tests were run for both high and low fire conditions. Burns were monitored from cold start up through the entire fire cycle, burning large charges of wood (20-47 lbs.). Smoldering conditions were not tested. Emission rates ranged from 20-149 pounds per ton of wood burned. The authors contend that their tests are representative of common practices in the Pacific Northwest and WMSCPI concurs.

EPA has published emission factors for residential wood stoves based on the 1977 work of Butcher and Sorenson. Those figures are unrealistic for all the reasons discussed above.

Otis used a composite particulate emission factor of 25 pounds per ton of wood burned, based on Snowden (1975) and an early work by Butcher and Buckley (1977). The use of this level is felt to be too low for all the reasons discussed above.

Wood Stoves - Discussion

None of the above studies attempted to measure pollutant outputs of stoves operated under starved air conditions. Several point to this omission and recommend further study. It is critical that this type of burning be considered in estimating pollutant output, as starved air burning represents at least 45 to 54% of the device hours burned per week in the four cities surveyed. For this reason, and lacking conclusive data, WMSCPI chose to adopt two emission factors for wood stoves.

For high fire burning (>6 lbs/hr) values of 50 pounds of particulate and 260 pounds of CO per ton of wood burned were adopted. These values are consistent with the data, especially given that the Oregon high fire tests used relatively dry wood.

For low fire burning (<6 lbs/hr) values of 100 pounds of particulate and 440 pounds of CO per ton of wood burned were used. These values are high, but are believed to be representative or even conservative estimates of pollutant outputs from common wood stoves.

VI. Preliminary Computations

Trucks to Cords

One of the necessary manipulations of the data was the conversion of peoples' estimates of the number of pickup truck loads of wood they had burned to cords of wood. For this conversion, WMSCPI adopted the method used by Otis and will not repeat an explanation here. Simply reviewed the approximations of truck size to cords are as follows: small, medium, large pickup truck equals .8, .9 and 1 cord respectively. See Otis, page 2 for complete information.

Cords to Tons - Table 4

For this conversion, WMPSCI used the method described by Otis to develop a "composite" specific gravity for the woods available in each city. This requires knowing the percent species composition of available woods (See Table 4) and the specific gravity of each. From these, a composite specific gravity is computed and this value can then be converted to a general density of wood in each city, based on standard tables for this conversion.*

*Via Interpolation of Table A3-7, The Wood Handbook

Table 4

Computation of Weight/Cord

	Cities												
	Bozeman			Great Falls			Helena			Kalispell			
Wood Species[a]	D.F.	L.P.P.	Other	D.F.	L.P.P.	Other	D.F.	L.P.P.	P.P	D.F.	L.P.P.	W.L.	Other
Specific Gravity (g/cc)[b]	.50	.41	.50	.50	.41	.50	.50	.41	.40	.50	.41	.52	.50
Species Composition (%)[c]	14	85	01	09	90	01	30	60	10	25	25	45	05
Specific Gravity x % Species Composition[d]	.07	.3485	.005	.045	.369	.005	.15	.246	.04	.125	.1025	.234	.025
General Specific Gravity (g/cc)[e]	.4235			.419			.436			.487			
Moisture Content (%)[f]	25			25			25			25			
General Density (lb/ft^3)[g]	33.1			32.725			34.0			38.31			
Volume/Cord[h]	87.5			87.5			87.5			87.5			
Pounds/Cord	2896.25			2863.44			2975.0			3352.13			
Tons/Cord	1.45			1.43			1.49			1.68			

a. Douglas Fir, Lodgepole Pine, Ponderosa Pine, Western Larch
b. The Wood Handbook
c. U.S.F.S.
d. the product of the specific gravity x % species composition
e. the sum of "d"
f. a general moisture content felt to be representative-conservative of commonly burned wood
g. via interpolation using Table A 3-7, The Wood Handbook
h. as computed by Otis

For purposes of this conversion, it is necessary to assign a moisture content to the wood being considered. Otis computed the % moisture to be 16.9% for woods in the Missoula area. We believed this estimate to be too low. For the purposes of this study, WMSCPI, in discussion with the Missoula Air Quality Unit personnel (who are updating the Otis study) decided a figure of 25% moisture was probably more representative of commonly used fuels. Consequently, the density computed for each city is based on 25% moisture content.

The final part of this computation (See Table 4) is multiplying the appropriate density by the volume of a cord of wood. For this conversion, Otis's volume of 87.5 ft^3/cord was adopted.

Pollutant Mass Rate (PMR) - Device Hour Method

The pollutant mass rate is the output of pollutant per unit time of burning. Deriving an approximate standard rate was necessary to perform later calculations. The PMR's presented in Tables 3a and 3b are, with the exception of the WMSCPI estimate, derived from experimental data. In some cases, this rate was measured by the original researchers and is listed in the tables as presented in the studies. In all other cases, this figure was calculated from the data in the listed studies using the equation shown in Note b of Table 3a. As indicated in that explanation, in all instances where a PMR was measured, the use of the above equation produced somewhat lower values for the PMR. WMSCPI, therefore, feels that the values shown are fair conservative representations.

The PMR's from the emission studies shown in Table 3 are for comparison to the general PMR's for each WBD developed by WMSCPI (Final listings of Table 3). These values were calculated based on the average burn rate and

the pollutant emission output (emission factor) per ton of wood burned for each type device. This rate was used in the computer program to calculate an estimate of total pollutant output based on residents' estimates of the number of hours they operate their WBD. These estimates of daily hourly use were multiplied by the appropriate burn rate and PMR and summed to calculate wood burned and emission outputs.

This calculation provides one of the two ways that estimates of wood burned and emissions were made. This method is of course only as valid as are the many variables involved, but it may provide a valuable indicator of pollutant outputs if the variables can be further refined and/or verified. This method can also provide a check of the reliability of respondents' estimates of WBD use through regression analysis. This is discussed briefly below.

The use of this method of computing emission outputs is reflected throughout the remainder of this report. Its results are indicated as the "PMR Method."

Burn Rate - Wood Burned Method

A second method based on the respondents' estimates of how much wood they had burned was also used to calculate pollutant outputs. Several factors complicated this computation. First multiple emission factors were used based on WBD and, in the case of stoves, on the method of operation. Second, many homes surveyed had more than one burning device. (See Appendix E). Since each device burns at a different rate and emits varying levels of pollutants, some method of compensating for these differences must be used in order to estimate the amount of wood burned. The method used

was to develop a composite emission factor based on the differing burn rates and the different amount of time that the various devices are used. The method is as follows.

First, a set of weighting factors were developed based on the percentage of the total burn rate represented by each type device. The method and the weighting factors are shown in Table 5. This weighting compensates for the differences in burn rate among the devices.

Second, a calculation was made to create a second weighting factor to account for the differing periods that each device is used. (See Table 8 for data on this parameter) Then that factor was multiplied by the appropriate emission factor and summed to arrive at a composite EF. This EF was then multiplied by the estimate of total wood burned to arrive at a grand pollutant output.

The computation was as follows:

$$WFi \times \% TDHi = Qi$$

$$\sum_{i=1}^{n} Qi = WT$$

$$\sum_{i=1}^{n} \{(Qi/WT) \times EFi\} = CEF \text{ (pounds/ton)}$$

$$CEF \times \text{Total Tons Wood Burned} = \text{pollutant output}$$

Where:

WF = Weighting Factor for each device - shown in Table 5.

% TDH = Percent of Total Device Hours represented by each device and mode of operation.

Q = A weighting factor representing the unique situation of each device considering both burn rate and percent of time a device is operated.

WT = A representation of the total of the various weighting factors; division of Q by WT represents the percent of the total that each parameter Q contributes.

EF = Emission Factor for each device (See Table 3).

CEF = Composite Emission Factor for the particular combination of wood burning habits in each city.

This calculation is based on estimates made by respondents of both amount of wood burned and the amount of time they operate their WBD's. It is, therefore, only as valid as those estimates. Results of this computation are indicated as either the wood burned or burn rate method.

TABLE 5

Burn Rate Weighting Factors

Wood Burning Device	Burn Rate (1 lb./hr.)	/TBR	x7	=	Weighting Factor
Fireplace	15.62	/87.917	x7		1.24
Airtight Stove-High	11.699	/87.917	x7		.931
Airtight Stove-Low	3.675	/87.917	x7		.293
Non Airtight Stove-High	11.699	/87/917	x7		.931
NATS Low	3.675	/87.917	x7		.293
Wood Furnace	29.85	/87.917	x7		2.38
Cook Stove	11.699	/87.917	x7		.931
Total Burn Rate (TBR)	87.917	-------	--		-----

RESULTS

The majority of this section is grouped into sets of data tables (identical in form) for each of the four cities surveyed. Each table will only be discussed fully the first time it appears. Subsequently, only interesting features of repetitive tables will be mentioned. The section is concluded with a brief "combined" review of two interesting parameters, wood age and storage, and draft settings on stoves.

The cities are discussed in the following order: Helena, Bozeman, Great Falls and Kalispell.

Results - Helena

Table 6 shows the percentage of people burning in Helena and the upper and lower limits of this figure based on the specified probability levels. It also projects this percentage onto the total number of households in the greater urban area.

Table 7 shows the percentages and numbers of households burning for the reasons specified by the sample. The "reasons" are the same breakdown used by Otis. The only "definition" supplied to the respondents of this question was "the main reason" for burning. The categories were mentioned and the response recorded.

This analysis was not designed to handle multiple responses and does not account for people who burned for more than one reason. The results reflect only the "main reason" people burn and are not a measure of how many opted to burn for auxiliary heat because they enjoy it.

TABLE 6 Helena

Number and Percent of Households Burning in a
City of 15847 Residences

Based on a sample size of 431, 145 burned wood and 286 did not.
All figures are projected to city wide totals and percentages.

	Probability Level	Lower Limit	Mean	Upper Limit
PERCENT	0.01	27.86	33.64	39.77
	0.05	29.19	33.64	38.32
	0.10	28.88	33.64	37.58
	0.15	30.32	33.64	37.10
	0.20	30.67	33.64	36.73
	0.25	30.96	33.64	36.42
NUMBERS	0.01	4415.03	5331.36	6301.80
	0.05	4625.89	5331.36	6072.02
	0.10	4734.57	5331.36	5955.21
	0.15	4805.51	5331.36	5878.83
	0.20	4860.50	5331.36	5820.11
	0.25	4906.28	5331.36	5771.65

TABLE 7 Helena

The Reasons for and Numbers of Households Burning
City Wide

Reason to Burn	90% Lower Limit	Percent Homes	90% Upper Limit
Primary Heat	7.29	9.51	12.17
Auxiliary Heat	11.04	13.69	16.72
Cooking	0	0	0.53
Enjoyment	7.90	10.21	12.93
No Response		0.23	
		Number of Homes	
Primary Heat	1154.54	1507.49	1928.03
Auxiliary Heat	1749.85	2169.31	2648.91
Cooking	0	0	84.45
Enjoyment	1252.45	1617.79	2049.43
No Response		36.77	

Table 8 is a summary of wood burning activities in Helena by both type of wood burning device and how much it is used. The first two rows show the number of households sampled that had at least one WBD and then the total number of devices found. These figures are then projected onto the population of the city. Rows five and six show the percentage of the devices surveyed represented by each type device and then considers the percentage of the city population owning each type. The total of this row is not equal to the sum across it, because some people own more than one type device.

Next Table 8 lists the sample results for device hours per week for each kind of WBD and then projects this onto the city population to arrive at an estimate of total device hours per device per week. This figure is expanded to reflect the device hours per 120 day burning season in the last row.

Finally, the 9th and 10th rows show the average number of device hours per week each device is used and the percentage of the total device hours represented by each device. This is an interesting breakdown of the data because it demonstrates that even though fireplaces represent 55% of the devices found and that 19% of the households own them, they make up only about 18% of the device hours each week. In contrast, airtight stoves make up only 31% of the devices found and are owned by only 12.5% of the population, but their use represents almost 66% of the hours that wood is being burned each week. This trend is verified by the findings shown in Table 9.

TABLE 8 Helena

Summary of Wood Burning by Device

Parameter	Fireplaces	Airtight Stoves	Non Air-tight Stoves	Wood Furnaces	Cook Stoves	Total
# Homes - Sample[a]	83	54	20	2	3	145[r]
# Devices - Sample[b]	97	55	20	2	3	177
# Homes - City[c]	3052	1985	735	74	110	5331[r]
# Devices - City[d]	3566	2022	735	74	110	6507
% Devices - Sample[e]	54.8	31.1	11.3	1.1	1.7	100
% City[f]	19.26	12.53	4.64	0.46	0.70	33.64[s]
Device Hrs/Wk Sample[g]	1265	4601	630	336	154	6986
Device Hrs/Wk City[h]	46,512	169,173	23,174	12,354	5662	256,875
Average Device Hrs/Wk[k]	15.24	85.21	31.51	168.0	51.3	$\bar{x}$ = 48.3
% Device Hrs/Week[m]	18.1	65.9	9.0	4,8	2.2	----
Device Hrs/ Burning Season[p]	797,223	2,889,639	397,203	211,748	97,051	4,392,864

a. *Number of homes sampled owning a particular WBD.*
b. *Number of devices owned.*
c. *Number of homes in the city expected to own a WBD.*
d. *Number of devices expected in the city.*
e. *Percent of devices sampled represented by a particular WBD.*
f. *Percent of city owning a particular type WBD.*
g. *Device hours/week/WBD in sample.*
h. *Device hours/week expected in the city.*
k. *Average device hours/week for each WBD.*
m. *Percent of total device hours/week represented by each WBD.*
p. *Device hours/WBD/120 day burning season.*
r. *May not equal sum due to multiple number of devices owned.*
s. *Percent of total population burning wood. This value may not equal the sum of previous values due to some invalid responses and data overlap.*

TABLE 9 Helena

Wood Consumption and Emission Outputs by WBD
Based on Device Hours - Pollutant Mass Rate
Estimates Based on 17.1 Week Burning Season

	Fireplaces	Airtight Stoves	Non Airtight Stoves	Wood Furnace	Cook Stoves
Tons Wood Burned - Sample	169.34	306.26	43.02	85.95	15.4
Tons Particulate - Sample	2.54	9.43	1.3	0.31	0.39
Tons CO - Sample	16.93	46.11	6.4	1.4	2.0
Tons Wood Burned - City	6226.	11,260	1582	3160.	567.7
Tons Particulate - City	93.4	346.8	48	11.5	14.2
Tons CO - City	622.6	1695.45	235.7	52.94	73.5

Table 9 is a listing of the total tons of wood burned and resulting emissions during a 120 day burning season. Results are shown for both the sample and projections onto the city population. It is broken down by wood burning device and is based on the WMSCPI PMR estimates. The table shows the relative contribution to total pollutant output of each WBD. It reflects the data found in Table 8 as to the percent contribution of each type device to the total number of device hours of wood burning.

TABLE 10 Helena

Totals - PMR Estimates vs. Respondents' Estimates of Wood Burned

Type Estimate	Tons Wood Burned-Sample	Tons Wood Burned-City	Total Tons Particulate-City	Total Tons CO-City
Respondents	464.561	17,080.973	378.86	1993.0
WMSCPI	620.016	22,796.692	514.005	2680.231

Table 10 compares the results of the two methods of determining the quantity of wood burned and pollutant outputs. It shows the total estimates based on the wood burners' guesses as to how much wood they burned, and the results of the WMSCPI PMR estimation. Both types of computation have the weaknesses pointed out above, so the choice of which set of figures to accept is left to the reader.

The differences in these figures indicate the problems of basing such calculations on estimations as to the amount of time one burns and/or total wood burned. WMSCPI expected this would be the case, and therefore, pursued both methods of calculations.

Regression Analysis

To investigate further the strengths and weaknesses of peoples' estimates about their wood burning, a multilinear regression was performed on the amount of time people say they burn and the amount of wood they say they burned, broken down by device. As might be expected from the data in Table 10, a very poor correlation was demonstrated, ranging from 26 to about 50% (See Appendix F). This indicates that only a small amount of the variation in peoples' estimates of wood burned can be explained by variation in the amount of time they say they burn.

There are three possible reasons for this result. 1) One or more of the parameters used in the calculations were in error, 2) people can not accurately estimate their hours of burning and/or the quantity of wood they burn, or 3) there are so many different ways to operate wood burning devices that there really is no consistent, universally applicable relationship between burning time and the amount of wood burned. The reality is probably a combination of the three choices, with emphasis on one or both parts of the second. Taking all this into consideration, it is only possible to say that the figures presented in Table 10 represent "ball park" estimates.

An interesting statistic generated by the regression analysis was the mean number of cords of wood burned per households in each city. They were as follows:

Bozeman - 2.26

Great Falls - 2.51

Helena - 2.14

Kalispell - 3.20

Table 11 is a breakdown of the sample data based on the census "tract" groupings established for each city. (See Appendix C) It shows the number of households sampled in each tract and the percentage of those surveyed that burned. If it is assumed that the sample of each tract is representative of the entire tract, then the sample percentages burning wood may represent the tract. This comparison may be valid for the tracts with relatively large number of people surveyed.

Table 12 is an estimation of seasonal wood burning and pollutant outputs by census tract. It is based only on the sample size and cannot be extrapolated to city size except for Helena. This is done in Table 13, using preliminary projections of total housing units for the various census tracts. Wood burning projections are made in this table for demonstration purposes only and should not be considered definitive. This calculation (Table 13) was completed only for Helena, where "ball park" figures of housing units by census enumeration districts were available. More reliable data was not available to WMSCPI in time to complete the study. As more accurate figures become available from the 1980 census, this calculation can be applied more productively to all four cities. The calculation was made by simply projecting a ratio of the numbers and percentages of households burning wood onto projections of the total housing units per census unit by ED. (See Appendix C)

Table 14 shows the expected expansion in wood burning during the next two years, assuming no growth in the city population. It shows the number of each WBD found among the sample and the projected growth for each. The expected increase is based on all the people who responded affirmatively to the question and half of the number who responded maybe (i.e. 50/50

TABLE 11 Helena

Wood Burning By Census Tract

Census Tract[a]	Homes Surveyed	% Burning Wood	90% U.L.	90% L.L.	Prob. % = $\bar{x}$ = 33.6
1	53	43.40	55.60	31.77	10.37
2	39	17.95	31.09	8.74	4.84
3	86	22.09	30.71	14.98	2.70
4	80	16.25	24.59	9.89	0.08
5	69	44.93	55.52	34.67	3.80
6	25	72.00	86.05	53.77	0.00
7	10	50.00	77.76	22.24	15.96
8	10	30.00	60.66	8.73	89.84
9	18	50.00	70.87	29.13	9.22
10	3	100.00	100.00	46.41	7.62
11	5	40.00	81.07	7.64	42.90
12	5	40.00	81.07	7.64	42.90
13	13	23.08	49.46	6.60	62.79
14	9	33.33	65.49	9.78	71.46
15					
16	6	66.67	93.72	27.15	3.72
Total	431	33.64	37.58	29.88	95.49

a. See Appendix C for explanation of census tract designations.

TABLE 12 Helena

Seasonal Wood Use and Emissions by Census Tract
Based on Respondents' Estimates of Wood

WMSCPI and PMR Method

Census Tract #	N1[a]	Respondents' Estimated Wood Use (Tons)	N2[b]	Device Hour Estimate (Tons)	CO Emitted Tons	Particulate Emitted (Tons)
1	21	73.19	20	124.79	17.32	3.41
2	6	22.60	5	10.44	1.58	0.32
3	16	41.67	15	102.38	6.63	1.22
4	12	40.03	12	36.75	4.57	0.85
5	26	94.16	25	104.47	14.41	2.80
6	15	62.28	14	76.42	10.60	2.09
7	4	13.04	3	19.06	3.17	0.66
8	2	20.12	2	15.62	1.67	0.27
9	8	30.84	7	44.44	5.52	1.01
10	3	8.94	3	9.56	1.40	0.28
11	0	0.00	0	0.00	0.00	0.00
12	1	11.92	0	0.00	0.00	0.00
13	3	12.29	3	8.01	0.80	0.12
14	2	19.00	2	9.17	1.97	0.44
15						
16	2	14.90	2	15.37	2.81	0.60
Total	121	464.56	113	593.08	74.08	14.38

a. N1 = Number of people who estimated how much wood they burned.
b. N2 = Number of people who estimated how many hours they burned.

TABLE 13 Helena

Total Wood Use and Emissions by Census Tract

Based on WMSCPI PMR Method

Census Tract	NT[a]	Total Wood Burners	Total Tons Wood Burned	CO Emitted Tons	Particulates Emitted-Tons
1	1024	444.4	2411.1	334.6	65.9
2	1013	181.8	271.0	41	8.4
3	2627	580.4	3127.4	202.4	37.4
4	2613	424.6	1200	149.3	27.9
5	1823	819	2760	380.7	74.1
6	1011	727.9	3090.3	428.5	84.4
7	426	213.0	811.7	135	28.2
8	573	172.0	895.1	95.6	15.5
9	465	232.5	1148	142.7	26.2
10	849	849.0	2706	395.7	80.1
11	450	180.0	0[b]	0	0
12	166	66.4	0[b]	0	0
13	264	60.9	162.7	16.3	2.4
14	164	54.7	167	35.9	8.1
15	23	0	0	0	0
16	250	166.7	640	117	25
Total	13,741	4,622.8	18,908	2,361.6	458.3

a. NT = total number of occupied homes in tract

b. insufficient data to make estimation

TABLE 14 Helena

Expected Growth in Wood Burning
During the Next 2 Years

WBD	Present Devices (#)	Expected Increase[a] (#)	Expected Increase[b] %/Device	Expected Increase % Total Use[c.d.e.]
Fireplaces	97	4.5	4.64	1.04
Airtight Wood Stoves	55	26	47.27	6.03
Non-Airtight Wood Stoves	20	2.5	12.50	0.58
Wood Furnaces	2	2.5	125.0	0.58
Cook Stoves	3	0	0	0
Total				8.24

a. Projected increase in number of WBD's in sample population.

b. Percent increase represented in numbers of WBD's.

c. Expected increase in usage of WBD computed for the present city population. This figure is not representative of any other growth, i.e., new construction.

d. Calculated by the equation : $\% = \frac{\text{Projected \# Devices}}{N} - \frac{\text{Present \# Devices}}{N} \times 100$

e. This projection is based on the total sample contacted in each city, even though the entire sample did not respond to the question. This serves to deflate the estimation. Coupled with the fact that this growth is projected only for the present population, these projections are conservative at best.

Note: N = 413

chance). The expected increase in % device use is a measure of expected expansion in the use of that particular device. The final column on total expected increase is based on the expected change in percent use of a device over the next two years. (See note c of Table 14) This figure was calculated based on the entire sample, even though not all respondents' answered the question. This serves to decrease the expected increase from what it may actually be. In addition, as noted above and in the table, this Table represents only the sampled population and therefore the city at its present size. No consideration was made for other potential growth, such as new construction. The growth projections are therefore conservative.

The final Tables, 15 and 16 are summaries of the data concerning wood storage habits and methods of stove operation. They may be useful for planning whether and/or what directions to pursue in trying to educate the burning public regarding wood burning emissions. A need for such a campaign might be indicated by the number of people that do not cover their firewood and by the percentages of stove owners that regularly operate their devices under starved air conditions. The figures shown in Table 16 describing this latter factor are only in relation to the percentage of the stoves' owners and are not related to the contribution of the device to total device hours. This would be an interesting and more meaningful calculation.

TABLE 15

Wood Age and Storage

Parameter	Bozeman(%)	Great Falls(%)	Helena(%)	Kalispell(%)
Amount Wood Dead at Least 6 months[a]				
<40%	0.0	1.89	0.74	1.32
40-80%	2.4	2.83	3.676	6.62
80-100%	97.6	95.28	95.59	92.05
N[b]	125	106	136	151
Wood Stored Covered[c]	74.5	69.32	59.86	72.78
Wood Not Covered	25.95	30.28	40.14	27.22
N	131	109	142	158
Wood Stored Split or with Diameter <6"[d]	80.3	76.85	78.87	78.34
Other	19.7	23.5	21.13	21.66
N	132	108	142	157
Unsplit Wood with Length <3'[e]	96.15	96.0	90.0	90.91
>3'	3.85	4.0	10.0	9.1
N	26	25	30	33

a. 6 months was taken to be the minimum time for consideration of wood as cured

b. N = number of valid responses to each question, not the entire wood-burning population

c. covering wood can greatly reduce moisture content

d. split and small diameter wood will cure more rapidly

e. unsplit wood greater than 3 feet in length will cure relatively slowly

TABLE 16

Summary of Stove Draft Settings

City	Airtight			Non-Airtight		
	N1	N2	% Closing Draft[a.]	N1	N2	% Closing Draft
Bozeman	33	33	48.48	24	24	29.17
Great Falls	39	35	42.86	12	10	20.0
Helena	54	51	43.14	20	16	31.25
Kalispell	71	64	51.56	25	20	65.0

N1 = number of sample with specified device

N2 = number of owners responding to question

a. = percent of respondents (N2) that operate the device with the draft closed

TABLE 6 Bozeman

Number and Percent of Households Burning in a
City of 10555 Residences

Based on a sample size of 417, 134 burned wood and 283 did not.
All figures are projected to city wide totals and percentages.

	Probability Level	Lower Limit	Mean	Upper Limit
PERCENT	0.01	26.36	32.13	38.33
	0.05	27.67	32.13	36.85
	0.10	28.36	32.13	36.10
	0.15	28.80	32.13	35.62
	0.20	29.15	32.13	35.25
	0.25	29.44	32.13	34.94
NUMBERS	0.01	2782.32	3391.77	4045.84
	0.05	2920.60	3391.77	3889.32
	0.10	2993.06	3391.77	3810.62
	0.15	3040.26	3391.77	3759.47
	0.20	3077.11	3391.77	3720.12
	0.25	3107.54	3391.77	3687.55

TABLE 7 Bozeman

The Reasons for and Numbers of Households Burning
City Wide

Reason to Burn	90% Lower Limit	Percent Homes	90% Upper Limit
Primary Heat	6.06	8.15	10.71
Auxiliary Heat	9.68	12.23	15.19
Cooking	0	0	0.55
Enjoyment	8.81	11.27	14.15
No Response		0.48	
		Number of Homes	
Primary Heat	639.36	860.60	1130.12
Auxiliary Heat	1021.44	1290.90	1603.59
Cooking	0	0	58.14
Enjoyment	930.29	1189.65	1493.18
No Response		50.62	

TABLE 8 Bozeman

Summary of Wood Burning by Device

Parameter	Fireplaces	Airtight Stoves	Non Air-tight Stoves	Wood Furnaces	Cook Stoves	Total
# Homes - Sample[a]	88	33	26	1	1	134[r]
# Devices - Sample[b]	103	34	27	1	1	166
# Homes - City[c]	2227	835	658	25	25	3391.77[r]
# Devices - City[d]	2607	860.6	683.4	25	25	4200
% Devices - Sample[e]	62.0	20.5	16.3	0.6	0.6	100
% City[f]	21.10	7.91	6.24	0.24	0.24	32.13[s]
Device Hrs/Wk Sample[g]	1445.42	3620.5	1355.5	5	35	6461.42
Device Hrs/Wk City[h]	36,586	91,641	34,310	127	886	163,550
Average Device Hrs/Wk[k]	16.42	109.71	52.14	5	35	$\bar{x}$ = 50.4
% Device Hrs/Week[m]	22.4	56	21.0	0.1	0.5	
Device Hrs/ Burning Season[p]	627,088	1,570,730	588,074	2,169	15,184	2,803,245

a. *Number of homes sampled owning a particular WBD.*
b. *Number of devices owned.*
c. *Number of homes in the city expected to own a WBD.*
d. *Number of devices expected in the city.*
e. *Percent of devices sampled represented by a particular WBD.*
f. *Percent of city owning a particular type WBD.*
g. *Device hours/week/WBD in sample.*
h. *Device hours/week expected in the city.*
k. *Average device hours/week for each WBD.*
m. *Percent of total device hours/week represented by each WBD.*
p. *Device hours/WBD/120 day burning season.*
r. *May not equal sum due to multiple number of devices owned.*
s. *Percent of total population burning wood. This value may not equal the sum of previous values due to some invalid responses and data overlap.*

TABLE 9 Bozeman

Wood Consumption and Emission Outputs by WBD
Based on Device Hours - Pollutant Mass Rate
Estimates Based on 17.1 Week Burning Season

	Fireplaces	Airtight Stoves	Non Airtight Stoves	Wood Furnace	Cook Stoves
Tons Wood Burned - Sample	193.5	231.7	102.8	1.3	3.5
Tons Particulate - Sample	2.9	7.3	2.95	0.005	0.088
Tons CO - Sample	19.4	35.5	14.7	0.021	0.454
Tons Wood Burned - City	4898	5865	2601	32.4	88.8
Tons Particulate - City	73.5	184.7	74.6	0.118	2.2
Tons CO - City	489.8	897.8	371.7	0.542	11.5

Table 9 is a listing of the total tons of wood burned and resulting emissions during a 120 day burning season. Results are shown for both the sample and projections onto the city population. It is broken down by wood burning device and is based on the WMSCPI PMR estimates. The table shows the relative contribution to total pollutant output of each WBD. It reflects the data found in Table 8 as to the percent contribution of each type device to the total number of device hours of wood burning.

TABLE 10 Bozeman

Totals - PMR Estimates vs. Respondents' Estimates of Wood Burned

Type Estimate	Tons Wood Burned-Sample	Tons Wood Burned-City	Total Tons Particulate-City	Total Tons CO-City
Respondents	436.222	11,105.624	272.3	1447.07
WMSCPI	532.755	13,484.959	335.149	1771.336

TABLE 11 Bozeman

Wood Burning By Census Tract

Census Tract[a]	Homes Surveyed	% Burning Wood	90% U.L.	90% L.L.	Prob. % = $\bar{x}$ = 32.1
1	111	27.03	34.83	20.17	29.27
2	105	24.76	32.66	17.97	12.55
3	60	28.33	39.42	18.93	63.19
4	88	34.09	43.29	25.72	60.52
5	12	66.67	87.71	39.10	0.58
6	3	33.33	86.46	1.69	48.68
7	2	100.00	100.00	31.62	20.65
8	18	61.11	80.10	39.21	0.55
9	4	75.00	98.72	24.87	2.13
10	12	41.67	68.47	18.11	30.92
Total	416	31.97	35.94	28.19	99.00

a. See Appendix C for explanation of census tract designations.

TABLE 12 Bozeman

Seasonal Wood Use and Emissions by Census Tract
Based on Respondents' Estimates of Wood

WMSCPI and PMR Method

Census Tract #	N1[a]	Respondents' Estimated Wood Use (Tons)	N2[b]	Device Hour Estimate (Tons)	CO Emitted Tons	Particulate Emitted (Tons)
1	30	107.37	30	136.81	18.17	3.45
2	20	70.22	20	110.64	12.43	2.15
3	15	50.12	15	43.74	5.96	1.16
4	27	59.41	27	77.56	8.92	1.55
5	8	39.88	8	62.75	7.94	1.46
6	1	4.35	1	0.80	0.08	0.01
7	2	13.05	2	27.36	4.50	0.95
8	8	37.88	8	39.31	5.68	1.14
9	3	29.73	3	48.28	6.23	1.20
10	5	16.68	5	31.95	4.26	0.86
11	0	0.00	0	0.00	0.00	0.00
Total	119	426.22	119	592.41	76.17	14.30

a. N1 = Number of people who estimated how much wood they burned.
b. N2 = Number of people who estimated how many hours they burned.

TABLE 14 Bozeman

Expected Growth in Wood Burning
During the Next 2 Years

WBD	Present Devices (#)	Expected Increase[a] (#)	Expected Increase[b] %/Device	Expected Increase[c.d.e.] % Total Use
Fireplaces	103	3.5	3.4	0.84
Airtight Wood Stoves	34	21.5	63.24	5.16
Non-Airtight Wood Stoves	27	4.5	16.67	1.08
Wood Furnaces	1	1.5	150.0	0.36
Cook Stoves	1	0.5	50.0	0.12
Total				7.55

a. Projected increase in number of WBD's in sample population.

b. Percent increase represented in numbers of WBD's.

c. Expected increase in usage of WBD computed for the present city population. This figure is not representative of any other growth, i.e., new construction.

d. Calculated by the equation : $\% = \frac{\text{Projected \# Devices}}{N} - \frac{\text{Present \# Devices}}{N} \times 100$

e. This projection is based on the total sample contacted in each city, even though the entire sample did not respond to the question. This serves to deflate the estimation. Coupled with the fact that this growth is projected only for the present population, these projections are conservative at best.

Note: N = 417

TABLE 6 Great Falls

Number and Percent of Households Burning in a City of 28297 Residences

Based on a sample size of 415, 112 burned wood and 303 did not. All figures are projected to city wide totals and percentages.

	Probability Level	Lower Limit	Mean	Upper Limit
PERCENT	0.01	21.56	26.99	32.98
	0.05	22.77	26.99	31.53
	0.10	23.41	26.99	30.81
	0.15	23.84	26.99	30.34
	0.20	24.16	26.99	29.98
	0.25	24.43	26.99	29.68
NUMBERS	0.01	6100	7636.78	9332
	0.05	6444	7636.78	8923
	0.10	6625	7636.78	8717
	0.15	6745	7636.78	8585
	0.20	6837	7636.78	8483
	0.25	6914	7636.78	8399

TABLE 7 Great Falls

The Reasons for and Numbers of Households Burning
City Wide

Reason to Burn	90% Lower Limit	Percent Homes	90% Upper Limit
Primary Heat	3.82	5.54	7.76
Auxiliary Heat	8.86	11.33	14.21
Cooking	0	0	0.55
Enjoyment	7.36	9.64	12.36
No Response		0.482	
		Number of Homes	
Primary Heat	1080.10	1568.27	2196.35
Auxiliary Heat	2506.82	3204.72	4021.78
Cooking	0	0	156.52
Enjoyment	2081.52	2727.42	3498.38
No Response		136.37	

TABLE 8 Great Falls

Summary of Wood Burning y Device

Parameter	Fireplaces	Airtight Stoves	Non Air-tight Stoves	Wood Furnaces	Cook Stoves	Total
# Homes - Sample[a]	73	39	12	2	0	112[r]
# Devices - Sample[b]	96	42	12	2	0	152
# Homes - City[c]	4977.5	2659.2	812.2	136	0	7636.8[r]
# Devices - City[d]	6546	2864	812	136	0	10,358
% Devices - Sample[e]	63.2	27.6	7.9	1.3	0	100
% City[f]	17.59	9.4	2.89	0.48	0	26.99[s]
Device Hrs/Wk Sample[g]	2002	3567	338.9	150	0	6058.1
Device Hrs/Wk City[h]	136,506	243,246	23,107	10,227	0	413,086
Average Device Hrs/Wk[k]	27.42	91.47	28.24	75	0	$\bar{x}$ = 52.39
% Device Hrs/Week[m]	33.0	58.9	5.9	2.5	0	
Device Hrs/ Burning Season[p]	2,339,719	4,169,240	396,061	175,305	0	7,080,325

a. *Number of homes sampled owning a particular WBD.*
b. *Number of devices owned.*
c. *Number of homes in the city expected to own a WBD.*
d. *Number of devices expected in the city.*
e. *Percent of devices sampled represented by a particular WBD.*
f. *Percent of city owning a particular type WBD.*
g. *Device hours/week/WBD in sample.*
h. *Device hours/week expected in the city.*
k. *Average device hours/week for each WBD.*
m. *Percent of total device hours/week represented by each WBD.*
p. *Device hours/WBD/120 day burning season.*
r. *May not equal sum due to multiple of number of devices owned.*
s. *Percent of total population burning wood. This value may not equal the sum of previous values due to some invalid responses and data overlap.*

TABLE 9 Great Falls

Wood Consumption and Emission Outputs by WBD
Based on Device Hours - Pollutant Mass Rate
Estimates Based on 17.1 Week Burning Season

	Fireplaces	Airtight Stoves	Non Airtight Stoves	Wood Furnace	Cook Stoves
Tons Wood Burned - Sample	267.992	251.886	21.2	38.4	0.0
Tons Particulate - Sample	4.02	7.509	0.0676	0.14	0.0
Tons CO - Sample	26.799	37.021	3.3	0.643	0.0
Tons Wood Burned - City	18,273.21	17,174.997	1444.6	2616.4	0.0
Tons Particulate - City	274.098	512.038	46.1	9.5	0.0
Tons CO - City	1827.321	2524.3	223.4	43.8	0.0

Table 9 is a listing of the total tons of wood burned and resulting emissions during a 120 day burning season. Results are shown for both the sample and projections onto the city population. It is broken down by wood burning device and is based on the WMSCPI PMR estimates. The table shows the relative contribution to total pollutant output of each WBD. It reflects the data found in Table 8 as to the percent contribution of each type device to the total number of device hours of wood burning.

TABLE 10 Great Falls

Totals - PMR Estimates vs. Respondents' Estimates of Wood Burned

Type Estimate	Tons Wood Burned-Sample	Tons Wood Burned-City	Total Tons Particulate-City	Total Tons CO-City
Respondents	398.4	27,166.335	575.46	3169.51
WMSCPI	579.4	39,509.278	841.791	4618.794

TABLE 11 Great Falls

Wood Burning By Census Tract

Census Tract[a]	Homes Surveyed	% Burning Wood	90% U.L.	90% L.L.	Prob. % = $\bar{x}$ = 27.0
1	6	0	31.86	0	30.30
2	20	35.0	55.8	17.73	29.03
3	26	15.38	31.83	5.43	26.13
4	14	21.43	46.56	6.11	90.50
5	28	14.29	29.77	5.03	18.28
6	6	0	31.86	0	30.30
7	22	13.64	31.6	3.82	23.41
8	12	8.33	33.87	0.43	24.95
9	26	26.92	44.67	13.38	80.6
10	20	35.0	55.8	17.73	29.03
11	31	41.94	58.21	26.89	4.51
12	21	0	8.80	0	0.08
13	11	9.09	36.43	0.47	31.84
14	25	28.0	46.23	13.95	71.19
15	30	73.33	85.98	57.01	0
16	38	13.16	25.70	5.33	6.93
17	17	58.82	78.81	36.39	0.25
18	16	25.0	48.44	9.02	88.40
19	31	41.94	58.21	26.89	4.51
20	6	16.67	58.17	0.85	97.49
21	1	0	89.99	0	53.98
Total	411	27.25	31.10	23.65	85.42

A. See Appendix C for explanation of census tract designations.

TABLE 12 Great Falls

Seasonal Wood Use and Emissions by Census Tract
Based on Respondents' Estimates of Wood

WMSCPI and PMR Method

Census Tract #	N1[a]	Respondents' Estimated Wood Use (Tons)	N2[b]	Device Hour Estimate (Tons)	CO Emitted Tons	Particulate Emitted (Tons)
1	0	0	0	0	0	0
2	7	19.66	6	19.22	2.51	0.46
3	4	6.44	3	5.83	0.71	0.13
4	3	7.86	3	2.96	0.53	0.11
5	2	11.44	2	7.94	0.96	0.17
6	0	0	0	0	0	0
7	2	6.44	2	6.0	0.62	0.10
8	1	2.86	1	6.0	0.60	0.09
9	7	11.44	6	11.06	0.51	0.08
10	7	16.44	5	19.06	2.10	0.35
11	11	72.25	11	90.14	10.29	1.77
12	0	0	0	0	0	0
13	1	.72	1	1.07	0.11	0.02
14	6	50.1	6	88.42	12.16	2.38
15	22	74	22	98.34	8.21	1.45
16	4	11.44	4	35.60	4.29	0.75
17	8	54.16	8	91.41	11.46	2.14
18	4	2.07	4	1.97	0.26	0.05
19	11	52.98	11	113.91	12.88	2.18
20	1	6.44	1	2.0	0.2	0.03
21	0	0	0	0	0	0
Total	101	398.418	96	600	67.7	12.1

a. N1 = Number of people who estimated how much wood they burned.
b. N2 = Number of people who estimated how many hours they burned.

TABLE 14 Great Falls

Expected Growth in Wood Burning
During the Next 2 Years

WBD	Present Devices (#)	Expected Increase (#)[a]	Expected Increase %/Device[b]	Expected Increase % Total Use[c.d.e.]
Fireplaces	96	5	5.21	1.2
Airtight Wood Stoves	42	31	73.81	7.47
Non-Airtight Wood Stoves	12	10	83.33	2.41
Wood Furnaces	2	1.5	75.0	0.36
Cook Stoves	0	0	0	0
Total				11.45

a. Projected increase in number of WBD's in sample population.

b. Percent increase represented in numbers of WBD's.

c. Expected increase in usage of WBD computed for the present city population. This figure is not representative of any other growth, i.e., new construction.

d. Calculated by the equation: $\% = \frac{\text{Projected \# Devices}}{N} - \frac{\text{Present \# Devices}}{N} \times 100$

e. This projection is based on the total sample contacted in each city, even though the entire sample did not respond to the question. This serves to deflate the estimation. Coupled with the fact that this growth is projected only for the present population, these projections are conservative at best.

Note: N = 415

TABLE 6 Kalispell

Number and Percent of Households Burning in a
City of 9253 Residences

Based on a sample size of 406, 163 burned wood and 243 did not.
All figures are projected to city wide totals and percentages.

	Probability Level	Lower Limit	Mean	Upper Limit
PERCENT	0.01	33.91	40.15	46.64
	0.05	35.34	40.15	45.09
	0.10	36.08	40.15	44.32
	0.15	36.57	40.15	43.81
	0.20	36.95	40.15	43.42
	0.25	37.26	40.15	43.10
NUMBERS	0.01	3138.05	3714.87	4315.20
	0.05	3270.47	3714.87	4172.55
	0.10	3338.94	3714.87	4100.56
	0.15	3384.06	3714.87	4053.57
	0.20	3418.75	3714.87	4017.57
	0.25	3447.78	3714.87	3987.66

TABLE 7 Kalispell

The Reasons for and Numbers of Households Burning
City Wide

Reason to Burn	90% Lower Limit	Percent Homes	90% Upper Limit
Primary Heat	13.54	16.50	19.84
Auxiliary Heat	11.51	14.29	17.46
Cooking	0.01	0.25	1.16
Enjoyment	5.37	7.39	9.89
No Response		1,724	
		Number of Homes	
Primary Heat	1252.59	1526.97	1835.37
Auxiliary Heat	1064.65	1321.86	1615.69
Cooking	1.17	22.79	107.58
Enjoyment	496.76	683.72	915.16
No Response		159.53	

TABLE 8 Kalispell

Summary of Wood Burning by Device

Parameter	Fireplaces	Airtight Stoves	Non Air-tight Stoves	Wood Furnaces	Cook Stoves	Total
# Homes - Sample[a]	75	71	25	8	3	406[r]
# Devices - Sample[b]	90	74	26	8	3	201
# Homes - City[c]	1709	1618	570	182	68	3715[r]
# Devices - City[d]	2051	1686	592	182	68	4579
% Devices - Sample[e]	44.8	36.8	12.9	4.0	1.5	100
% City[f]	18.47	17.49	6.16	1.97	0.74	40.15[s]
Device Hrs/Wk Sample[g]	3466	7527	1635	1131	96	13,855
Device Hrs/Wk City[h]	78,991	171,547	32,278	25,768	2,187	310,771
Average Device Hrs/Wk[k]	46.21	106	65.4	141	32	$\bar{x}$ = 85.73
% Device Hrs/Week[m]	25.0	54.3	11.8	8.2	0.7	
Device Hrs/ Burning Season[p]	1,353,907	2,940,321	638,961	441,674	37,500	5,412,363

a. *Number of homes sampled owning a particular WBD.*
b. *Number of devices owned.*
c. *Number of homes in the city expected to own a WBD.*
d. *Number of devices expected in the city.*
e. *Percent of devices sampled represented by a particular WBD.*
f. *Percent of city owning a particular type WBD.*
g. *Device hours/week/WBD in sample.*
h. *Device hours/week expected in the city.*
k. *Average device hours/week for each WBD.*
m. *Percent of total device hours/week represented by each WBD.*
p. *Device hours/WBD/120 day burning season.*
r. *May not equal sum due to multiple of number of devices owned.*
s. *Percent of total population burning wood. This value may not equal the sum of previous values due to some invalid responses and data overlap.*

TABLE 9 Kalispell

Wood Consumption and Emission Outputs by WBD
Based on Device Hours - Pollutant Mass Rate
Estimates Based on 17.1 Week Burning Season

	Fireplaces	Airtight Stoves	Non Airtight Stoves	Wood Furnace	Cook Stoves
Tons Wood Burned - Sample	464	465.72	95.48	289.24	9.62
Tons Particulate - Sample	6.96	14.94	3.17	1.1	0.24
Tons CO - Sample	46.4	72.33	15.22	4.84	1.25
Tons Wood Burned - City	10,574	10,614	2176	6592	219.4
Tons Particulate - City	158.6	340.8	72.29	24	5.5
Tons CO - City	1057.4	1648.5	346.77	110.4	28.4

Table 9 is a listing of the total tons of wood burned and resulting emissions during a 120 day burning season. Results are shown for both the sample and projections onto the city population. It is broken down by wood burning device and is based on the WMSCPI PMR estimates. The table shows the relative contribution to total pollutant output of each WBD. It reflects the data found in Table 8 as to the percent contribution of each type device to the total number of device hours of wood burning.

TABLE 10 Kalispell

Totals - PMR Estimates vs. Respondents' Estimates of Wood Burned

Type Estimate	Tons Wood Burned-Sample	Tons Wood Burned-City	Total Tons Particulate-City	Total Tons CO-City
Respondents	896.998	20,443.169	405.09	2161.58
WMSCPI	1324.027	30,175.437	601.249	3191.529

TABLE 11 Kalispell

Wood Burning By Census Tract

Census Tract[a]	Homes Surveyed	% Burning Wood	90% U.L.	90% L.L.	Prob. % = $\bar{x}$ = 40.1
1	12	83.33	96.96	56.19	0.07
2	31	61.29	75.92	44.95	1.06
3	3	0.00	53.59	0.00	42.88
4	38	50.00	64.26	35.74	16.24
5	17	41.18	63.61	21.19	72.85
6	14	64.29	84.72	39.05	3.60
7	5	60.00	92.36	18.93	17.64
8	32	37.50	53.57	23.26	91.00
9	14	14.29	38.54	2.60	7.77
10	20	40.00	60.64	21.70	81.94
11	24	29.17	47.88	14.57	37.59
12	8	50.00	80.71	19.29	35.19
13	6	66.67	93.72	27.15	8.33
14	24	29.17	47.88	14.57	37.59
15	27	22.22	39.22	10.15	8.15
16	23	13.04	30.37	3.65	0.99
17	24	33.33	52.15	17.79	64.52
18	10	70.00	91.27	39.34	2.52
19	23	34.78	54.05	18.63	76.56
20	34	35.29	50.82	21.78	69.53
21	1	100.00	100.00	10.01	80.30
22	5	0.00	36.91	0.00	15.36
23	3	33.33	86.46	1.69	70.83
24	8	75.00	95.36	40.03	1.75
Total	406	40.15	44.32	36.08	95.70

a. See Appendix C for explanation of census tract designations.

TABLE 12 Kalispell

Seasonal Wood Use and Emissions by Census Tract
Based on Respondents' Estimates of Wood

WMSCPI and PMR Method

Census Tract #	N1[a]	Respondents' Estimated Wood Use (Tons)	N2[b]	Device Hour Estimate (Tons)	CO Emitted Tons	Particulate Emitted (Tons)
1	9	67.20	9	74.50	9.76	1.87
2	15	111.00	15	198.18	19.21	3.58
3	0	0	0	0	0	0
4	15	129.81	14	189.37	18.87	3.76
5	4	44.10	3	126.52	5.30	1.08
6	9	39.48	8	59.49	8.50	1.69
7	3	10.50	3	23.64	2.36	0.36
8	10	73.58	10	103.03	12.61	2.28
9	2	6.72	2	4.108	0.73	0.15
10	7	32.16	7	30.03	3.79	0.68
11	6	22.05	4	49.17	5.72	0.97
12	4	39.98	3	117.08	6.96	1.11
13	4	33.60	4	19.62	4.29	0.97
14	6	62.72	5	63.66	7.49	1.29
15	6	25.20	5	38.38	5.55	1.12
16	2	7.56	2	63.40	6.34	0.95
17	7	22.08	7	30.28	3.31	0.55
18	5	36.46	5	40.98	5.44	1.03
19	6	49.28	5	123.40	8.59	1.71
20	10	40.32	9	71.08	8.18	1.42
21	1	8.40	0	0	0	0
22	0	0	0	0	0	0
23	1	8.40	0	0	0	0
24	3	23.52	2	14.02	1.58	0.27
Total	135	897	122	1411.09	147.48	27.45

a. N1 = Number of people who estimated how much wood they burned.
b. N2 = Number of people who estimated how many hours they burned.

TABLE 14 Kalispell

Expected Growth in Wood Burning
During the Next 2 Years

WBD	Present Devices (#)	Expected Increase[a] (#)	Expected Increase[b] %/Device	Expected Increase % Total Use[c.d.e.]
Fireplaces	90	2	2.22	0.49
Airtight Wood Stoves	74	24	33.11	5.91
Non-Airtight Wood Stoves	26	7.5	28.85	1.85
Wood Furnaces	8	6.5	81.25	1.60
Cook Stoves	3	1.0	33.33	0.25
Total				10.10

a. Projected increase in number of WBD's in sample population.

b. Percent increase represented in numbers of WBD's.

c. Expected increase in usage of WBD computed for the present city population. This figure is not representative of any other growth, i.e., new construction.

d. Calculated by the equation: $\% = \frac{\text{Projected \# Devices}}{N} - \frac{\text{Present \# Devices}}{N} \times 100$

e. This projection is based on the total sample contacted in each city, even though the entire sample did not respond to the question. This serves to deflate the estimation. Coupled with the fact that this growth is projected only for the present population, these projections are conservative at best.

Note: N = 406

CONCLUSIONS

There are two types of data in this report: 1) the solid results based strictly on numbers of people burning, the reasons they burn and the expected growth; 2) the data based on estimates made by the respondents. The first category is fully supportable and falls easily into the 90% confidents limits. The second category is rife with uncertain variables and guesses. Data from this area should be treated as best estimates based on best estimates.

Besides the uncertainties of even the emission testing data, another factor which complicates interpretation of the results is the unusual mildness of this past winter. As a result of this factor, it may be that some of the results, i.e., the PMR estimates may be more reflective of a more typical winter. This may be the case, because this method relied on estimates of usual time burning even though this was not a usual winter.

On the other hand, the wood burned estimates may be more representative of this winter, because the respondents may have had a more accurate idea of the amount of wood they burned.

RECOMMENDATIONS FOR FUTURE STUDIES

Recommendations for improving future studies of this kind fall into three basic categories: 1) sample selection, 2) changes in questionnaire format, and 3) refinements in handling parameters critical to emission outputs.

Problems developed during the course of this study due to errors in the Polk Directories such as inaccurate or nonexistent addresses and streets. It would not have been a problem except that by the time the mistakes were discovered, it was too late to select more addresses from which to sample. Consequently, the sample was held to smaller than optimum size. Future studies should begin with a sufficiently large sample to ensure adequacy of the final results to whatever confidence levels are desired.

Four problems became apparent as a result of the format of the questionnaire. They all essentially arose from a lack of adequate answer-options and encoding space to fully represent the responses. Specifically, we recommend (in ascending importance): 1) Use a system that allows multiple responses for reasons to burn, with clearly defined differentiation. 2) Use some method of encoding that will indicate the presence of a WBD even if the household is not presently burning. That this would be a problem became apparent too late to change the data input format. 3) Use a standardized encoding for people who burn less than one day per week that has options from which to choose. This choice was standardized for this study, but not with desired accuracy. 4) Most importantly, provide a better system for delineating device hours for each device owned. For example, if a household has two fireplaces, be able to show the use patterns for each separately. This will provide much greater accuracy than did the WMSCPI format which necessarily treated all of the same device equally.

The final set of recommendations are the most important, in that they relate to the accuracy of pollution output projections. WMSCPI recommends the following: 1) Future studies should specifically address whether a stove has a thermostatic damper. This was not discerned in this study, but should have been, as this

type device contributes significantly to total starved air burning. Simply asking if the draft is usually closed for operation, while producing interesting results, probably confused many respondents with thermostatic devices and therefore may have masked the full extent of starved air burning.

2) The pollution potentials of airtight and non-airtight stoves should be more clearly differentiated than is possible with current data. The present study was constrained by lack of information into treating both kinds of devices the same.

3) As more source specific emission testing is completed, both the emission factors and the pollutant mass ratings for all devices should be refined. Future studies will probably greatly expand the usable data base by more fully exploring the variables critical to emission outputs. Especially important will be the development of more data on starved air burning. Other factors that need to be examined are mentioned in the following recommendations.

4) The affect of moisture content on emission levels should be more clearly defined and incorporated into future surveys. In addition, some more reliable way of estimating fuel moisture content of common firewoods based on cutting and storage techniques needs to be developed.

5) The affects of burning chamber size and configuration need to be further assessed, as does fuel size, geometry and surface to volume ratio.

6) Finally, the impact on emissions of the amount of fuel loaded into the burning chamber at one time needs to be fully assessed, as what little testing has been done points to this parameter as having a major influence on pollutant outputs.

BIBLIOGRAPHY

1) Allen, John M. 1981. "Control of Emissions from Residential Wood Burning by Combustion Modification" in Wood Heating Seminar, 1980/1981. Wood Heating Alliance, Suite 700, 1101 Connecticut Ave., N.W., Wash., D.C. 20036

2) Brackebusch, Arthur P. 1975. "Gain And Loss Of Moisture In Large Forest Fuels". Research Paper Int-173. Intermountain Forest and Range Experiment Station. Forest Service. U.S.D.A. Ogden, Utah 84401

3) Butcher, Samuel S. and E.M. Sorenson. 1979. "A Study of Wood Stove Particulate Emissions" in Journal of the Air Pollution Control Assn. vol. 29, #7

4) Cooper, John A. 1980. "Environmental Impact of Residential Wood Combustion Emissions And Its Implications". Oregon Graduate Center. Beaverton, Or.

5) DeAngelis, D.G., D.S. Ruffin, and R.B. Reznik. 1980. "Preliminary Characterization of Emissions from Wood-fired Residential Combustion Equipment". Interagency Energy/Environment R&D Program Project. EPA-600/7-80-040. Contract No. 68-02-1874. Industrial Environmental Research Lab., Research Triangle Park, N.C. 27711

6) Esvelt, Terence G. and Mark L. Roberts. 1980. "The Use Of Wood For Residential Space Heating In The Pacific Northwest". Bonneville Power Admin., P.O. Box 3621, Portland, Or. 97208

7) Forest Products Laboratory. 1974. The Wood Handbook: Wood As An Engineering Material. Forest Service, U.S.D.A., Agricultural Handbook #72 U.S. Printing Office, Stock # 0100-03200

8) Hall, Alfred J. 1972. Forest Fuels, Prescribed Fire, and Air Quality. Pacific Northwest Forest and Range Experiment Station. Forest Service. U.S.D.A. Portland, Or.

9) Hayden, A.C.S. and R.W. Braaten. 1980. "Performance of Domestic Wood-Fired Appliances". Canadian Combustion Research Laboratory. Ottowa, Ontario

10) Hill, Richard C. 1979. "Design, Construction And Performance Of Stick-wood Fired Furnace For Residential And Small Commercial Application". Prepared for U.S. Dept. of Energy. Contract EC 77-5-02-45

11) Leonard, Ellen M. 1979. "Wood Burning for Power Production". LA-7924-MS. U.S. Printing Office. Stock # 061-000-00340-1

12) Omni Environmental Services. 1981. "Emission Test Report on Four Selected Wood Burning Home Heating Devices". Prepared for Oregon D.O.E., Labor and Industries Bldg., Rm. 102, Salem, Or. 97310

13) Otis, Ted. 1977. "Wood Burning and Particulate Air Pollution In The Missoula Valley". Missoula City-County Health Dept. Air Pollution Control Division. Missoula, Mt. 59801

14) PEDCo - Environmental, Inc. 1977. "Source Testing For Fireplaces, Stoves, And Restaurant Grills In Vail, Colorado". Contract No. 68-01-1999 Prepared for U.S. Environmental Protection Agency, Region 8, Denver, Colo. 80203

15) Peters, J.A., T.W. Hughes, and D.G. DeAngelis. 1981. "Wood Combustion Emissions At Elevated Altitudes" in Wood Heating Seminar, 1980/1981. Wood Heating Alliance, Suite 700, 1101 Connecticut Ave., N.W., Wash., D.C. 20036

16) Rossman, David R. and F. Glenn Odell. 1980. "Evaluation of Wood Stove Emissions". Prepared for Oregon Dept. of Environmental Quality and USEPA

17) Short, James E. 1974. "Particulate, Carbon Monoxide And Hydrocarbon Emissions From Residential Fireplaces", Air Quality Source Testing Report #74-1. Albuquerque Dept. of Environmental Health, Box 1293, Albuquerque, N.M. 87103

18) Snowden, W.D., D.A. Alguard, G.A. Swanson, and W.E. Stolberg. 1975. "Source Sampling Residential Fireplaces For Emission Factor Development". U.S. Environmental Protection Agency, National Air Data Branch, Technical Development Section. Contract No. 68-02-1992

19) U.S. Environmental Protection Agency. 1977. "Compilation Of Air Pollutant Emission Factors, Third Edition". Office of Air and Waste Management. Office of Air Quality Planning and Standards. Research Triangle Park, N.C. 27711

20) U.S. Environmental Protection Agency. 1979. "Supplement No. 9 For Compilation of Air Pollutant Emission Factors, Third Edition". Office of Air and Waste Management. Office of Air Quality Planning and Standards. Research Triangle Park, N.C. 27711

21) Wood, M., E. Howard, and W. Marlatt. 1976. "Air Quality Analysis - Vail, Colorado". Prepared for Camp Dresser and Mckee

APPENDIX A

SAMPLE SIZE AND SELECTION

The sample population of residences was selected from the 1980 edition of the Polk City Directory for each of the four cities surveyed. The University of Montana Decsystem 20 computer was used to generate a list of random numbers for each city (Great Falls, 700; Helena, 900; Kalispell, 800; Bozeman, 800) based on the particular structure of the Polk Directory for each city. By this technique, unique pairs of numbers were generated from: 1.) the total number of pages in the alphabetically-sorted address section of the directory, and 2.) the maximum number of lines per page. A transparent mask overlay for each city was then fabricated such that when positioned on the proper page in the directory, each pair of numbers would pinpoint one address. In this way, the numbers were transformed into sample residences; blank lines, businesses, street names, vacancies, etc., were thrown out in the selection process until 450 "valid" residential households were obtained.

The actual sample sizes used for the survey were (with one exception, Helena) slightly, but not significantly, less than the estimated sample sizes necessary to insure a theoretical confidence level of 90% (i.e. 10% maximum error). The required sample size for each city was determined by statistically analyzing data from the Otis Missoula Wood Burning Study. The method used in determining the required sample sizes for each city (Great Falls, 438; Kalispell, 423; Bozeman, 427; Helena, 430) is described in the attached sheets. Discrepancies between these theoretical sample sizes and the actual sample sizes (Great Falls, 415; Kalispell, 406; Bozeman, 417; Helena, 431) were due to failure to contact households, mistakes, and/or inaccuracies in the Polk Directories. These included mishandling of questionnaires (e.g., wrong numbers, etc.) and non-existent addresses. (See following table).

The desired population was all household units in the greater urban area of each of the four cities. Since the geographical layout of each city was unique, this area differed from one site to another but could reasonably be considered to be the area covered by the respective Polk City Directory.

TABLE 1

Interview Failures

City	Errors (#)[a]	Errors (%)[b]	Misses (#)[c]	Misses (%)[d]	Refusal (#)	Refusal (%)[d]
Bozeman	20	4.44	7	1.63	6	1.40
Great Falls	9	2.0	18	4.08	8	1.81
Helena	10	2.22	5	1.14	4	0.91
Kalispell	22	4.89	12	2.8	10	2.34

a. Errors in the Polk Directories and/or mistakes in handling the questionnaires

b. Percent based on total attempted sample of 450

c. Unsuccessful contact attempts at valid addresses

d. Percent based on total left after mistakes (i.e. 450-# errors)

DETERMINING THE PROPER SAMPLE SIZE

This section discusses the method of establishing the sample size required to enable one to state with a specified degree of confidence that the true proportion of people in a city who burn wood is within a specified range of the proportion found in a random sample of the city's population.

When sampling a population to determine the proportion of people who burn wood, the distribution of expected results follows the binomial distribution. The alpha level confidence limits to the experimentally observed proportion of wood burners (when sampling from a finite population) is given by:

$$p \pm t_{\alpha,\,(n-1)} * \sqrt{\frac{pq\,(N-n)}{n \cdot (N-1)}}$$

Where:

p = the proportion of wood burners in the sample
q = the proportion of those who do not burn wood
n = the sample size
N = the size of the total population
$t_{\alpha,\,(n-1)}$ = Student's t statistic corresponding to the alpha level of significance with (n-1) degrees of freedom

Requiring that the true proportion of wood burners be within a specified percent of the experimentally observed proportion requires that the term $t \cdot \sqrt{\frac{pq\,(N-n)}{n \cdot (N-1)}}$, when expressed as a percentage of the estimated value of wood burners, be less than the specified limit. This establishes the following relationship:

$$\frac{t \cdot \sqrt{\frac{pq\,(N-n)}{n\,(N-1)}}}{p} \leq \text{Limit of Error}$$

Given the probability level one wishes to work at, the maximum allowable error, the size of the population under study and an estimate of the propor-

tion of wood burners in the population, the above equation can be solved for n: the sample size needed.

Using the proportion of wood burners in Missoula as an estimate of p, the following table was constructed. It tabulates the n required to be 95% sure that the true proportion of wood burners is within various ranges of the observed proportion for cities of various sizes.

Table 2

City Size	Maximum allowable error 25%	10%	5%	1%
10,000	102	603	2,042	8,651
20,000	102	621	2,274	15,246
40,000	102	631	2,411	24,635
80,000	102	636	2,486	35,597
200,000	103	639	2,533	48,561
infinite	104	641	2,565	64,132

It can be seen from this table that a sample size of 1,000 is not too small and that sample sizes much smaller than 500 should be avoided. For example, in the Missoula study, the sample size was 337 and the population size was 21,000. The observed proportion of wood burners in that town was found to be 0.38. The 95% confidence limits for this statistic are:

Upper limit = 0.43
Lower limit = 0.32

This means that the true proportion of woodburners in Missoula is known to within 5 percentage points. ($38 \pm 5\%$). The error of 5 percentage points out of 38 is 15%. Based on these data, one can say that one is 95% sure that the true proportion of woodburners in Missoula is within 13% of 0.38. To demonstrate the slow rate at which the maximum error decreases as a function of sample size, Table 2 was constructed. Table 3 shows the 95% confidence limits for a true proportion of 0.4 for various sample sizes along with the % error that the range represents.

TABLE 3

n	upper limit		lower limit	maximum deviation from mean as a % of the mean
10	.74	p	.12	78
100	.50	p	.30	25
200	.47	p	.33	18
500	.44	p	.36	15
1,000	.43	p	.37	8
2,000	.42	p	.38	5

Appendix B

Western Montana Scientists' Committee
for Public Information
c/o Environmental Library
758 Eddy Street
University of Montana
Missoula, Montana
59812

March 11, 1981

Dear Ms./Sir:

We are conducting a survey for the Montana Department of Health and Environmental Sciences to determine the extent of wood burning for residential heating in Helena, Great Falls, Kalispell and Bozeman. Your name was selected at random from the Polk City Directory as a participant in the study.

Your cooperation in taking a few minutes to fill out the questionnaire will be appreciated. If we have not received a reply from you by March 23, you will be scheduled for a personal interview. A self-addressed stamped envelope is included for return of the completed questionnaire.

Your cooperation in completing the questionnaire is appreciated.

Sincerely,

William Tomlinson

William Tomlinson
Project Director

WDT/kn

APPENDIX C

CENSUS "TRACT" CODES

Following are lists by city of the enumeration divisions, block divisions, and/or census tracts that make up the census groupings found in this study. WMSCPI had hoped to provide maps of these groupings, but none of the appropriate scale for reduction were readily available. Consequently, locating the divisions in each city will require consulting a census map of that area.

BOZEMAN: KEY TO CENSUS DIVISIONS

Census Tract #	ED #	Block #
1	----	9901
2	----	9902
3	----	9903
4	----	9904
5	1643	
6	1640	
7	1639 1644	
8	1638	
9	1637	
10	1642	

GREAT FALLS: KEY TO CENSUS DIVISIONS

Standard, established census tract divisions (numbers 1 - 20) were used.

HELENA: KEY TO CENSUS DIVISIONS

Census Tract #	ED #	Block #
1	1020 - 1028	9901
2	1029 - 1033	9902
3	1034 -1039	9903
4	1040 - 1045	9904
5	1046 - 1053	9905
6	994	
7	993	
8	995	
9	992	
10	999	
11	998	
12	987	
13	988	
14	989	
15	990	
16	991	

KALISPELL: KEY TO CENSUS DIVISIONS

Census Tract #	ED #
1	1182, 1183
2	1185, 1186
3	eliminated: no regular ED designations
4	1174, 1176
5	1173, 1175
6	1184, 1243
7	1240
8	1190, 1193, 1260
9	1244, 1245, 1246
10	1242, 1247
11	1241, 1248, 1249
12	1250, 1251
13	1191, 1222, 1224
14	1256, 1257
15	1252, 1255
16	1253, 1254
17	1258, 1259
18	1192, 1194
19	1263, 1264
20	1261, 1262
21	1181
22	1179, 1180, 1187
23	1177, 1189, 1220
24	1188, 1189

APPENDIX D

OTHER PERTINENT EMISSION STUDIES

Several other studies besides those listed in Table 3--Emission Factors, were important in the choice of specific factors used in this study. They were not included in the above Table because one of several aspects made them relatively incomparable with the studies listed. These aspects included use of a different measurement technique and/or burning a completely different type of wood for fuel. In spite of these facts, the studies which are excerpted for use in this appendix contained information which contributed to the choice of critical factors.

The information presented in the following pages has been taken completely out of context and is incomplete without the full reports from which it was taken. It is presented here because of its particular relevance to certain points raised in the report and the conciseness of this method of presentation. WMSCPI wishes to express apologies and appreciation to the respective authors.

Control of Emissions from Residential Wood Burning by Combustion Modification

by

John M. Allen
Battelle - Columbus Laboratories

Emission Factors pg 178

TABLE 1. EMISSIONS FROM DIFFERENT MODES OF BURNING FUEL: Oak 4 x 4's

Emissions THC, ppm	Emissions CO, percent	Emissions Factors 1b/1000 1b wood PAH	THC	CO	Excess Air, percent	Burning Rate, 1b/hr	Emission Rate lb/hr, THC	CO
		Side Draft Mode (Defiant)						
8300	1.8	ND	112	420	340	6.3	.7056	2.646
1900	0.6	ND	12	63	110	11.8	.1416	.7434
2800	1.2	ND	15	100	60	17.4	.261	1.74
6200	2.5	0.035	28	190	40	18.7	.5236	3.553
1800	0.5	0.045	9	40	130	18.4**	.1656	.736
		Down Draft Mode (Defiant)						
3100	0.2	ND	56	67	560	7.3*	.4088	.4891
3100	0.2	ND	56	64	560	10.3*	.5768	.6592
600	0.4	0.050	5	59	180	13.7	.0685	.8053
1000	0.5	ND	7	61	120	18.4	.1288	1.1224
		Up Draft Mode with Hearth (Defiant)						
1800	0.1	ND	113	90	2050	6.3	.7119	.567
1600	0.2	ND	19	33	290	10.2	.1938	.3366
1100	0.3	ND	8	37	140	14.4	.1152	.5328
		Up Draft Mode with Grate (Riteway)						
6700	2.5	ND	34	220	80	14.4*	.4896	3.168
7100	3.6	0.018	32	280	40	16.5	.528	4.62
5900	2.7	ND	34	170	80	20.9	.7106	3.553
9900	5.4	ND	42	400	30	27.1	1.1382	10.84
6400	2.3	ND	33	200	80	31.8*	1.0494	6.36
						$\bar{X}$ = 15.52		
		High Turbulence (Dumont)				σ = 6.95	$\bar{X}$ = .4657	$\bar{X}$ = 2.499
200	0.1	0.011	5	25	920	24.1*	σ = .3259	σ = 2.77
300	0.3	ND	2	30	110	21.9*		

* Oak Logs
** Green Pine

TABLE 4. EFFECTS OF AMOUNT OF WOOD CHARGED ON EMISSIONS

Side Draft Burning of Oak 4 x 4's
Data averages for each of 2 complete tests

Mass of Charge, lb	12.9	41.9
Burning Rate, lb/hr	17.4	19.2
Excess Air, %	62.9	58.1
Stack Temperature, F	680	660
(C)	(360)	(350)
Emissions:		
CO, percent	1.2	2.5
THC, ppm	2800	5300
Emission Factors, lb/1000 lb wood		
CO	100	220
THC	15	26

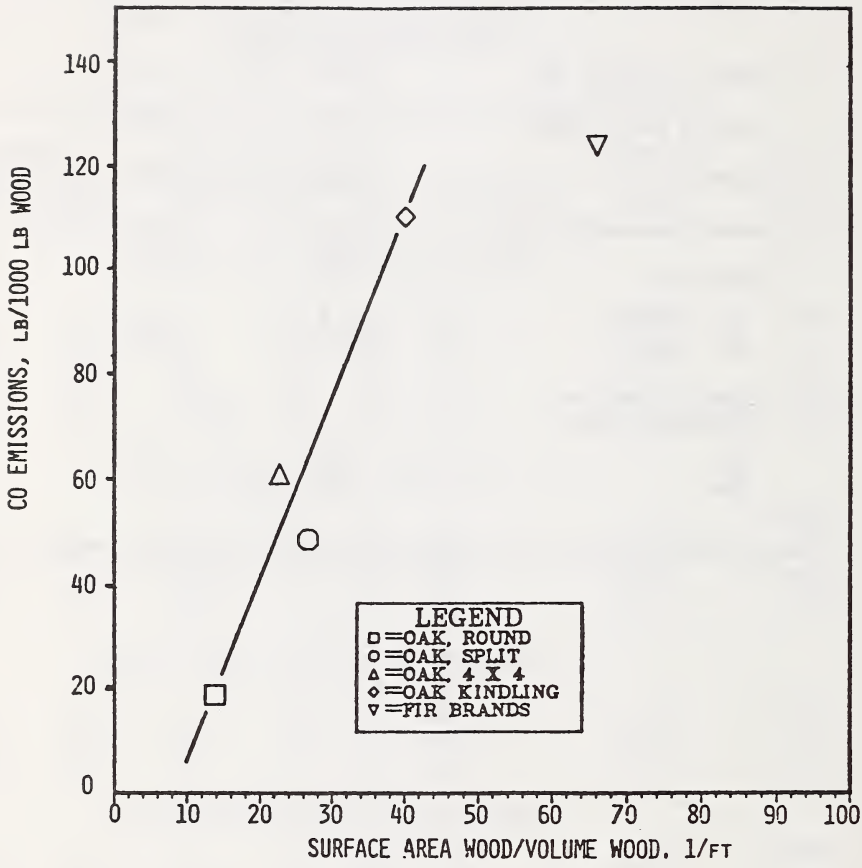

FIGURE 6. EFFECT OF WOOD SIZE ON CO EMISSION FACTORS

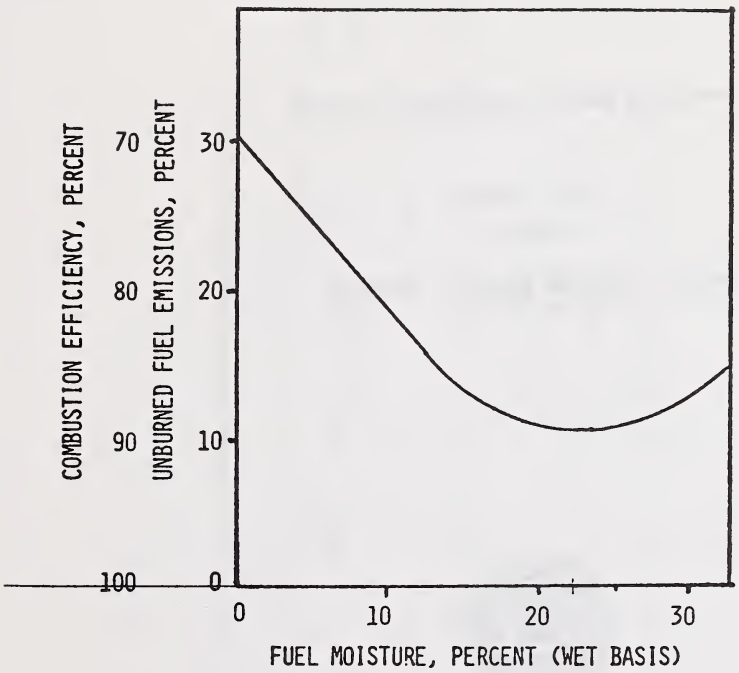

FIGURE 7. EFFECTS OF MOISTURE IN WOOD ON UNBURNED FUEL EMISSIONS

DATA FROM SHELTON ET AL ASHRAE TRANSACTIONS VOL. 48 PART 1 1178

Performance of Domestic Wood-Fired Appliances

A.C.S. Hayden

R.W. Braaten

Canadian Combustion Research Laboratory
Ottawa, Ontario

For Presentation at the 73rd Annual Meeting of the
Air Pollution Control Association
Montreal, Quebec **June 22-27, 1980**

Printed in U.S.A.

$\bar{x}$ moisture content = 14%

Table II. Effect of stove design on efficiency and emissions, moderate firing rate.

Stove Type	Burn Rate	Excess Air	Mean Stack Temperature	CO		HC	Combustible Loss	Efficiency	Heat Output	Emissions g/MJ Output	
				Emissions		Emissions					
	kg/h	%	°C	%	g/kg	g/kg wood	%	%	MJ/h	CO	HC
Fireplace	2.64	1863	92	.07	177	41.6	15.6	24.5	10.0	52.1	12.2
Updraft I	2.37	657	122	.67	184	43.4	16.3	58.0	21.2	22.9	5.4
Updraft II	2.45	576	124	.45	129	30.2	11.3	62.9	23.8	14.8	3.5
Horizontal Baffle	1.78	258	67	.87	140	32.9	12.3	76.2	21.2	13.3	3.2
Sidedraft	1.46	157	122	.81	87	20.4	7.7	76.7	17.3	8.2	1.9

$\bar{x}$ moisture content = 16%

Table III. Effect of stove design on efficiency and emissions, higher firing rate.

Stove Type	Burn Rate	Excess Air	Mean Stack Temperature	CO Emissions		HC Emissions	Combustible Loss	Efficiency	Heat Output	Emissions g/MJ Output	
	kg/h	%	°C	%	g/kg	g/kg wood	%	%	MJ/h	CO	HC
Updraft I	4.02	436	223	.47	116	27.2	10.2	56.5	35.1	14.8	3.5
Updraft II	4.05	153	139	.79	153	36.0	13.5	71.1	44.5	15.5	3.7
Horizontal Baffle	3.66	209	150	.95	108	25.4	9.5	69.9	40.0	11.2	2.6
Downdraft	4.46	62	117	2.37	169	39.8	14.9	72.4	49.9	16.8	4.0

ALBUQUERQUE DEPARTMENT
OF
ENVIRONMENTAL HEALTH

CITY HALL TELEPHONE
BOX 1293, ALBUQUERQUE, N. M. 87103

AIR QUALITY SOURCE TESTING REPORT # 74-1

Particulate, Carbon Monoxide And Hydrocarbon Emissions From Residential Fireplaces

Albuquerque, New Mexico

February 25, 1974

Testing And Report Prepared By

James E. Short

James E. Short,
Air Pollution Control Associate

ENVIRONMENTAL LIBRARY
758 Eddy Street
University of Montana
Missoula, Montana 59801

SUMMARY OF RESULTS

Location	Type of Wood	Stack Flow cfm	Particulate lbs./hr.	CO lbs./hr.	HC lbs./hr.
Valencia	Pinon	446	.17	1.5	.28
Moon	Pinon	377	.14	.43	.20
Moon	Mix	317	.18	1.3	.47
Natalie	Pinon	445	.21	1.1	.28
Natalie	Mix	444	.16	1.1	.18
Esther	Pinon	483	.28	1.1	.19
Esther	Mix	487	.22	1.8	.21
Average	Pinon		.20	1.0	.19
Average	Mix		.19	1.4	.29
Average	Composite		.19	1.2	.25

Note:

Hydrocarbon emissions from fireplaces were measured by the non-dispersive infrared technique as hexane and will be reported on that basis except when noted as being changed to a methane base. Because emissions factors and emissions inventory values for HC emissions are based on methane, caution should be taken before comparing fireplace HC emission data when corrections to the methane base have not been made.

TABLE 4

COMPARISON OF EMISSIONS FACTORS

Pollutant	Emission Factors Used Prior to 1973 Inventory*	Emission Factors Determined From 1974 Study #/ton
	(Figures in lbs. pollutant per ton wood burned)	
Particulate	25 to 30	57.9
CO	2	357.4
HC	2	14.1**

* Emissions factor for wood and bark combustion in boilers.
**Corrected to CH_4 base rather than C_6H_{14} as measured.

APPENDIX E

TABLE of MULTIPLE WBD OWNERSHIP

Following are tables which cross reference the percent of homes in each city that have various other woodburning devices, given the fact that they have one of the kind specified. For example, of the 73 people in Great Falls that own fireplaces, 15% also own airtight wood stoves and almost 7% own non-airtight stoves.

These tables point to the importance of using methods such as those in this study to differentiate among the various ways to burn.

GREAT FALLS

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	OTHER DEVICE= OWNED	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
	N					
FIREPLACES	73	100.00	15.07	6.85	1.37	0.00
AIRTIGHT WOOD STOVES	39	28.21	100.00	0.00	0.00	0.00
NON-AIRTIGHT WOOD STOVES	12	41.67	0.00	100.00	0.00	0.00
WOOD FURNACES	2	50.00	0.00	0.00	100.00	0.00
COOKSTOVES	0	0.00	0.00	0.00	0.00	0.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES		17.59	9.49	2.69	0.48	0.00

HELENA

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	OTHER DEVICE= OWNED	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
	N					
FIREPLACES	83	100.00	10.84	7.23	0.00	2.41
AIRTIGHT WOOD STOVES	54	16.67	100.00	1.85	0.00	0.00
NON-AIRTIGHT WOOD STOVES	20	30.00	5.00	100.00	0.00	0.00
WOOD FURNACES	2	0.00	0.00	0.00	100.00	0.00
COOKSTOVES	3	66.67	0.00	0.00	0.00	100.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES		19.26	12.53	4.64	0.46	0.70

KALISPELL

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	OTHER DEVICE= OWNED	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
	N					
FIREPLACES	73	100.00	13.70	9.59	0.00	0.00
AIRTIGHT WOOD STOVES	71	14.08	100.00	5.63	1.41	1.41
NON-AIRTIGHT WOOD STOVES	25	28.00	16.00	100.00	0.00	4.00
WOOD FURNACES	8	0.00	12.50	0.00	100.00	12.50
COOKSTOVES	3	0.00	33.33	33.33	33.33	100.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES		18.47	17.49	6.16	1.97	3.74

BOZEMAN

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	OTHER DEVICE= OWNED	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
	N					
FIREPLACES	88	100.00	9.09	7.95	1.14	3.03
AIRTIGHT WOOD STOVES	33	24.24	100.00	0.00	0.00	0.00
NON-AIRTIGHT WOOD STOVES	26	26.92	0.00	100.00	0.00	0.00
WOOD FURNACES	1	100.00	0.00	0.00	100.00	100.00
COOKSTOVES	1	0.00	100.00	0.00	0.00	100.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES		21.10	7.91	6.24	0.24	0.24

APPENDIX F

COMPUTER PRINTOUT

The following are computer printouts from a summary report program written for this survey. The printouts contain additional information that does not necessarily appear in the text.

THIS IS A SUMMARY OF GT. FALLS

OF THE 415 RESIDENCES SURVEYED, 112 BURN WOOD AND 303 DO NOT.

BASED ON THIS, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE PRECENTAGE OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	21.56	26.99	32.98
0.05	22.77	26.99	31.53
0.10	23.41	26.99	30.81
0.15	23.84	26.99	30.34
0.20	24.16	26.99	29.98
0.25	24.43	26.99	29.68

BASED ON A CITY OF 28297 RESIDENCES, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE NUMBER OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	6100.48	7636.78	9331.56
0.05	6443.53	7636.78	8923.00
0.10	6625.32	7636.78	8717.46
0.15	6744.64	7636.78	8585.05
0.20	6836.93	7636.78	8483.54
0.25	6914.31	7636.78	8399.06

OF THE 112 HOMES THAT BURN WOOD,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF WOOD BURNING HOMES	90% LOWER LIMIT
Primary Heat	27.82	20.54	14.46
Auxiliary Heat	50.18	41.96	34.08
Cooking	2.04	0.00	0.00
Enjoyment	43.83	35.71	28.18
No Response		1.786	

OF THE 415 HOMES THAT RESPONDED TO THE QUESTIONNAIRE,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF ALL HOMES	90% LOWER LIMIT
Primary Heat	7.76	5.54	3.82
Auxiliary Heat	14.21	11.33	8.86
Cooking	0.55	0.00	0.00
Enjoyment	12.36	9.64	7.36
No Response		0.482	

BASED ON A CITY SIZE OF 28297 RESIDENCES, THE ABOVE PERCENTAGES CORRESPOND TO THE FOLLOWING NUMBER OF HOMES:

REASON	90% UPPER LIMIT	NUMBER OF HOMES	90% LOWER LIMIT
Primary Heat	2196.35	1568.27	1080.11
Auxiliary Heat	4021.78	3204.72	2506.82
Cooking	156.52	0.00	0.00
Enjoyment	3498.38	2727.42	2081.52
No Response		136.371	

THIS IS A SUMMARY OF GT. FALLS 'S SURVEY DATA REGARDING FIREPLACES

OF THE 415 RESPONDENTS TO SURVEY 73 HAVE ONE OR MORE FIREPLACES

THIS CORRESPONDS TO 17.59% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 20.96 : 90% LOWER LIMIT= 14.576)
THERE WERE 2 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 28297 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 4977.5 HOMES. (90% UPPER LIMIT= 5929.7 : 90% LOWER LIMIT= 4124.5)

OF THE 73 PEOPLE WHO HAVE FIREPLACES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	51	21	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	70	29	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	10	26	9	9	4	5	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	14	36	12	5	7	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	1	5	0	6	19	16	7	5	3	1	2	2	0	1	0	0	1	0	0	1	0	0	0	0	0	3
% OF HOMES	1	7	0	8	26	22	10	7	4	1	3	3	0	1	0	0	1	0	0	1	0	0	0	0	0	4

BASED ON THE 72 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR FIREPLACES

THE TOTAL DEVICE HOURS PER WEEK= 1974.56 AND THE AVERAGE PER RESIDENCE= 27.424

PRORATING THESE LEVELS TO ALL 73 PEOPLE WHO HAVE FIREPLACES
THE TOTAL DEVICE HOURS PER WEEK= 2001.98

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 15.629 POUNDS OF WOOD PER HOUR)	267.992 TONS OF WOOD BEING BURNED
(BASED ON 1.562 POUNDS OF CO PER HOUR)	26.799 TONS OF CO BEING EMITTED
(BASED ON 0.234 POUNDS OF PARTICULATES PER HOUR)	4.020 TONS OF PARTICULATES BEING EMITTED

BASED ON 28297 HOMES IN THE CITY
THERE ARE 2339719.600 DEVICE HOURS
AND 18273.210 TONS OF WOOD BURNED
AND 1827.321 TONS OF Carbon Monoxide EMITTED
AND 274.098 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF FIREPLACES OVER A HEATING SEASON

THIS IS A SUMMARY OF GT. FALLS 'S SURVEY DATA REGARDING AIRTIGHT WOOD STOVES

OF THE 415 RESPONDENTS TO SURVEY 39 HAVE ONE OR MORE AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 9.40% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 12.10 : 90% LOWER LIMIT= 7.142)
THERE WERE 3 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 28297 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 2659.2 HOMES. (90% UPPER LIMIT= 3422.9 : 90% LOWER LIMIT= 2021.0)

OF THE 39 PEOPLE WHO HAVE AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	36	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	92	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	1	0	2	4	3	3	3	1	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	3	0	5	10	8	8	8	3	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	2	0	0	1	1	4	1	2	0	3	0	2	0	7	0	1	0	3	0	1	0	2	0	0	0	9
% OF HOMES	5	0	0	3	3	10	3	5	0	8	0	5	0	13	0	3	0	8	0	3	0	5	0	0	0	23

BASED ON THE 36 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 3293.00 AND THE AVERAGE PER RESIDENCE= 91.472

OF THE 35.0 PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
42.857% SAID IT WAS FULLY CLOSED AND 57.143% SAID IT WAS NOT

PRORATING THESE LEVELS TO ALL 39 PEOPLE WHO HAVE AIRTIGHT WOOD STOVES
THE TOTAL DEVICE HOURS PER WEEK= 3567.42

DUFING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.675 POUNDS PER HOUR WHEN IT IS CLOSED) 251.886 TONS OF WOOD BEING BURNED

(BASED ON 1.515 POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.81% POUNDS PER HOUR WHEN CLOSED) 37.021 TONS OF CO BEING EMITTED

(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.184 POUNDS PER HOUR WHEN CLOSED) 7.509 TONS OF PARTICULATES BEING EMITTED

BASED ON 28297 HOMES IN THE CITY
THERE ARE 4169242.60 DEVICE HOURS
AND 17174.997 TONS OF WOOD BURNED
AND 2524.278 TONS OF Carbon Monoxide EMITTED
AND 512.438 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF GT. FALLS 'S SURVEY DATA REGARDING NON-AIRTIGHT WOOD STOVES

OF THE 415 RESPONDENTS TO SURVEY 12 HAVE ONE OR MORE NON-AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 2.89% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 4.64 : 90% LOWER LIMIT= 1.677)
THERE WERE 3 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 28297 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 818.2 HOMES. (90% UPPER LIMIT= 1313.8 : 90% LOWER LIMIT= 474.4)

OF THE 12 PEOPLE WHO HAVE NON-AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	2	3	2	1	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	17	25	17	8	8	8	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	1	0	0	1	2	2	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% OF HOMES	8	0	0	8	17	17	8	25	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8

BASED ON THE 11 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR NON-AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 310.65 AND THE AVERAGE PER RESIDENCE= 28.241

OF THE 10.0 PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
20.000% SAID IT WAS FULLY CLOSED AND 80.000% SAID IT WAS NOT

PRORATING THESE LEVELS TO ALL 12 PEOPLE WHO HAVE NON-AIRTIGHT WOOD STOVES
THE TOTAL DEVICE HOURS PER WEEK= 338.89

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.675 POUNDS PER HOUR WHEN IT IS CLOSED) 21.187 TONS OF WOOD BEING BURNED

(BASED ON 1.515 POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.810 POUNDS PER HOUR WHEN CLOSED) 3.276 TONS OF CO BEING EMITTED

(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.184 POUNDS PER HOUR WHEN CLOSED) 0.676 TONS OF PARTICULATES BEING EMITTED

BASED ON 28297 HOMES IN THE CITY
THERE ARE 396061.882 DEVICE HOURS
AND 1444.642 TONS OF WOOD BURNED
AND 223.369 TONS OF Carbon Monoxide EMITTED
AND 46.114 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF NON-AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF GT. FALLS 'S SURVEY DATA REGARDING WOOD FURNACES

OF THE 415 RESPONDENTS TO SURVEY 2 HAVE ONE OR MORE WOOD FURNACES

THIS CORRESPONDS TO 0.48% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 1.51 : 90% LOWER LIMIT= 0.086)
THERE WERE 3 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 28297 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 136.4 HOMES. (90% UPPER LIMIT= 427.1 : 90% LOWER LIMIT= 24.2)

OF THE 2 PEOPLE WHO HAVE WOOD FURNACES
THE FOLLOWING ARE HISTOGRAMS OF:

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	0	0	50	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
% OF HOMES	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0

BASED ON THE 2 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR WOOD FURNACES

THE TOTAL DEVICE HOURS PER WEEK= 150.00 AND THE AVERAGE PER RESIDENCE= 75.000

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 29.850 POUNDS OF WOOD PER HOUR)	38.372 TONS OF WOOD BEING BURNED
(BASED ON 0.500 POUNDS OF CO PER HOUR)	0.643 TONS OF CO BEING EMITTED
(BASED ON 0.109 POUNDS OF PARTICULATES PER HOUR)	0.140 TONS OF PARTICULATES BEING EMITTED

BASED ON 28297 HOMES IN THE CITY
THERE ARE 4753305.000 DEVICE HOURS
AND 2616.428 TONS OF WOOD BURNED
AND 43.826 TONS OF Carbon Monoxide EMITTED
AND 9.545 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF WOOD FURNACES OVER A HEATING SEASON

THIS IS A SUMMARY OF GT. FALLS 'S SURVEY DATA REGARDING COOKSTOVES

OF THE 415 RESPONDENTS TO SURVEY 0 HAVE ONE OR MORE COOKSTOVES

THIS CORRESPONDS TO 0.00% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 0.55 : 90% LOWER LIMIT= 0.000)
THERE WERE 3 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 28297 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 0.0 HOMES. (90% UPPER LIMIT= 156.5 : 90% LOWER LIMIT= 0.0)

THIS IS A SUMMARY OF THE TOTAL WOOD USE IN GT. FALLS AMONG THE HOMES SURVEYED

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	152.0	96.0	42.0	12.0	2.0	0.0
DEVICE HOURS/WEEK	6058.292	2001.984	3567.417	338.891	150.000	0.000
% OF DEVICES		63.2	27.6	7.9	1.3	0.0
% OF DEVICE.HOURS/WEEK		33.0	58.9	5.6	2.5	0.0

BASED ON A CITY SIZE OF 28297 THE ABOVE DATA TRANSLATES INTO THE FOLLOWING # OF DEVICES AND HOURS IN OPERATION PER WEEK

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	15753.6	6545.8	2863.8	818.2	136.4	0.0
DEVICE HOURS/WEEK	25026073.000	136506.390	243246.240	23107.460	10227.831	0.000

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT
THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	N	OTHER DEVICE= OWNED	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
FIREPLACES	73		100.00	15.07	6.85	1.37	0.00
AIRTIGHT WOOD STOVES	39		28.21	100.00	0.00	0.00	0.00
NON-AIRTIGHT WOOD STOVES	12		41.67	0.00	100.00	0.00	0.00
WOOD FURNACES	2		50.00	0.00	0.00	100.00	0.00
COOKSTOVES	0		0.00	0.00	0.00	0.00	0.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES			17.59	9.40	2.89	0.48	0.00

OF THE 112 PEOPLE WHO BURN WOOD, 101 PEOPLE ALSO ESTIMATED HOW MUCH WOOD THEY BURN.
OF THESE 96 ALSO ANSWERED THE QUESTIONNAIRE REGARDING HOW MUCH THEY USE THEIR WOOD BURNING DEVICES

BASED ON THE 101 PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURN, THERE WERE 251.25 CORDS BURNED.
PRORATING THIS TO ALL 112 PEOPLE IN THE SURVEY WHO BURN WOOD, THIS CORRESPONDS TO 278.61 CORDS OF WOOD BURNED.
PRORATING THIS TO ALL 7636.78 HOMES IN THE CITY OF GT. FALLS THAT BURN WOOD, THIS EQUALS 18997.44 CORDS OF WOOD.

USING A CONVERSION FACTOR OF 1.430 TONS OF WOOD PER CORD THIS CORRESPONDS TO 27166.335 TONS OF WOOD BURNED IN THE CITY.

BASED ON A CONVERSION FACTOR OF 42.4 POUNDS OF Particulate PER TON OF WOOD BURNED, THE CITY EMITS 575.46 TONS OF PARTICULATE

GIVEN A CONVERSION FACTOR OF 233.3 POUNDS OF Carbon Monoxide PER TON OF WOOD BURNED, THE CITY EMITS 3169.51 TONS OF CO
COMPARE THE ABOVE ESTIMATES WITH THE FOLLOWING ESTIMATES THAT ARE BASED ON THE HOURLY RATES ASSUMED FOR THE VARIOUS DEVICES

THE TOTAL TONS OF WOOD BURNED= 39509.278
THE TOTAL TONS OF CO EMITTED= 4618.794
THE TOTAL TONS OF PARTICULATES= 841.791

THE FOLLOWING IS A SUMMARY OF THE TOTAL WOOD BURNED AND THE CARBON MONOXIDE AND PARTICULATES PRODUCED BY EACH CENSUS TRACT

THE FOLLOWING IS A BREAKDOWN OF THE PERCENTAGES OF HOMES IN EACH CENSUS TRACT THAT BURN WOOD

CENSUS TRACT	HOMES SURVEYED	HOMES BURNING WOOD	% BURNING WOOD	90%UL	90%LL	PROB % = CITY MEAN OF 27.0
1	6	0	0.00	31.86	0.00	30.30
2	20	7	35.00	55.80	17.73	29.03
3	26	4	15.38	31.83	5.43	26.13
4	14	3	21.43	46.56	6.11	90.50
5	28	4	14.29	29.77	5.03	18.28
6	6	0	0.00	31.86	0.00	30.30
7	22	3	13.64	31.60	3.82	23.41
8	12	1	8.33	33.87	0.43	24.95
9	26	7	26.92	44.67	13.38	80.60
10	20	7	35.00	55.80	17.73	29.03
11	31	13	41.94	58.21	26.89	4.51
12	25	0	0.00	8.80	0.00	0.08
13	11	1	9.09	36.43	0.47	31.84
14	25	7	28.00	46.23	13.95	71.19
15	30	22	73.33	85.98	57.01	0.00
16	38	5	13.16	25.70	5.33	6.93
17	17	10	58.82	78.85	36.39	0.25
18	16	4	25.00	48.44	9.02	88.40
19	31	13	41.94	58.21	26.89	4.51
20	6	1	16.67	58.17	0.85	97.49
21	1	0	0.00	89.99	0.00	53.98
ALL	411	112	27.25	31.10	23.65	85.42

THERE WERE 4.0 INVALID CENSUS TRACT NUMBERS FOUND

THIS IS A BREAKDOWN OF THE WOOD USE AND EMISSIONS OBSERVED IN THE SURVEY FOR EACH CENSUS TRACT
NOTE : THE BELOW TOTALS ARE PRORATED TO ALL THE PEOPLE SURVEYED THAT BURN WOOD IN A GIVEN CENSUS TRACT - c.f. THE ABOVE TABLE

CENSUS TRACT #0 IS THE TOTALS FOR ALL CENSUS TRACTS

NOTE:: n1 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURNED
n2 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MANY HOURS THEY USED THEIR DEVICES

CENSUS TRACT NUMBER	n1	PEOPLE'S ESTIMATE OF WOOD USE (TONS)	n2	DEVICE HOURS ESTIMATE OF WOOD USE (TONS)	CO EMITTED (TONS)	PARTICULATES EMITTED (TONS)
0	101	398.418	96	600.023	67.730	12.144
1	0	0.000	0	0.000	0.000	0.000
2	7	19.663	6	19.215	2.512	0.465
3	4	6.435	3	5.826	0.712	0.131
4	3	7.865	3	2.960	0.531	0.114
5	2	11.440	2	7.938	0.965	0.177
6	0	0.000	0	0.000	0.000	0.000
7	2	6.435	2	6.009	0.619	0.096
8	1	2.860	1	6.010	0.601	0.090
9	7	11.440	6	11.059	0.511	0.085
10	7	16.445	5	19.062	2.104	0.353
11	11	72.248	11	90.135	10.286	1.770
12	0	0.000	0	0.000	0.000	0.000
13	1	0.715	1	1.068	0.107	0.016
14	6	50.050	6	88.423	12.156	2.379
15	22	74.003	22	98.339	8.211	1.446
16	4	11.440	4	35.597	4.288	0.746
17	8	54.161	8	91.407	11.460	2.144
18	4	2.074	4	1.972	0.258	0.047
19	11	52.982	11	113.905	12.882	2.178
20	1	6.435	1	2.003	0.200	0.030
21	0	0.000	0	0.000	0.000	0.000

BECAUSE THERE ARE NO CENSUS TRACT DATA THE TOTALS CANNOT BE PRORATED TO THE ENTIRE CENSUS TRACT

THE FOLLOWING IS THE REGRESSION LINE OF TOTAL CORDS OF WOOD AS A FUNCTION OF TOTAL DEVICE HOURS/WEEK

PARAMETER	MEAN	STANDARD DEVIATION
TOTAL DEVICE HOURS PER WEEK	52.388	70.914
TOTAL CORDS OF WOOD BURNED	2.513	3.287

CORRELATION BETWEEN THE TWO = 0.6581

THE EQUATION OF THE REGRESSION LINE IS:

TOTAL CORDS USES PER SEASON PER HOUSEHOLD = 0.031 TIMES THE TOTAL DEVICE HOURS PER WEEK IN A HOME PLUS 0.913 CORDS

THE PROBABILITY THAT THE SLOPE OF THE REGRESSION LINE IS ZERO = -0.000
THE % OF THE TOTAL VARIANCE IN TOTAL CORDS OF WOOD USED PER HOME THAT IS EXPLAINED BY THE TOTAL DEVICE HOURS PER HOME= 43.311

THE MEAN # OF CORDS PER HOUSE= 2.51
THE MEAN NUMBER OF DEVICE HOURS PER WEEK PER HOUSE DUE TO
FIREPLACES = 19.370
AIRTIGHT WOOD STOVES = 28.219
NON-AIRTIGHT WOOD STOVES = 3.236
WOOD FURNACES = 1.563
COOKSTOVES = 0.000
*** TERMINAL ERROR (IER = 132) FROM IMSL ROUTINE RLMUL
ERROR IN RLMUL= 132

THE FIVE DIMENSION REGRESSION LINE =
THE # OF CORDS BURNED PER SEASON PER HOUSE HOLD =
0.000 TIMES THE # OF DEVICE HOURS PER WEEK FROM FIREPLACES +
0.000 TIMES THE # OF DEVICE HOURS PER WEEK FROM AIRTIGHT WOOD STOVES +
0.000 TIMES THE # OF DEVICE HOURS PER WEEK FROM NON-AIRTIGHT WOOD STOVES +
0.000 TIMES THE # OF DEVICE HOURS PER WEEK FROM WOOD FURNACES +
0.000 TIMES THE # OF DEVICE HOURS PER WEEK FROM COOKSTOVES +
PLUS 0.00 CORDS
THE PERCENT OF THE TOTAL VARIATION EXPLAINED BY THIS LINE= 0.000

THIS IS A SUMMARY OF QUESTIONS 12,13 & 14 FOR GT. FALLS

:::::::::: QUESTION 12 ::::::

THERE WERE 112 PEOPLE WHO SAID THEY BURN WOOD
OF THE 112 HOMES THAT BURN WOOD, 6. NEGLECTED TO STATE HOW MUCH OF THE WOOD HAS BEEN DEAD FOR AT LEAST 6 MONTHS
CONSEQUENTLY THE FOLLOWING WILL BE BASED ON THE 106 PEOPLE THAT ANSWERED THE QUESTION

THE AMOUNT OF WOOD DEAD FOR AT LEAST 6 MONTHS	NUMBER OF RESPONDENTS	% OF RESPONDENTS
< 40 %	2.0	1.887
40 - 80 %	3.0	2.830
80 - 100%	101.0	95.283

:::::::::::::: QUESTION 13 ::::::::::

THERE WERE 3.0 INVALID ANSWERS TO THIS QUESTION
OF THE 109 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 76.0 YES ANSWERS (69.72 %) I.E. WOOD IS COVERED
AND 33.0 NO ANSWERS (30.28 %) I.E. WOOD IS NOT COVERED

:::::::::::::::: QUESTIONS 14 & 15 ::::::::::

THERE WERE 4.0 INVALID ANSWERS TO THIS QUESTION
OF THE 108 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 83.0 YES ANSWERS (76.85 %) I.E. WOOD IS EITHER SPLIT OR DIAMETER IS LESS THAN 6"
AND 25.0 NO ANSWERS (23.15 %) I.E. WOOD IS NOT SPLIT AND DIAMETER IS GREATER THAN 6"

OF THE 25 PEOPLE THAT DID INDICATE HOW LONG THE UNCUT OR UNSPLIT WOOD WAS,
THERE WERE 1.0 (4.000%) WHO LEFT IN IN LENGTHS GREATER THAN 3 FEET
AND THERE WERE 24.0 (96.000%) WHO CUT IT SHORTER THAN 3 FEET

THE FOLLOWING IS A BREAKDOWN OF THE % OF HOMES THAT BURN WOOD AS A FUNCTION OF THE INTERVIEW TECHNIQUE USED

THERE WERE 415.0 RESPONSES TO THIS SURVEY

#	TECHNIQUE	# SURVEYED	# BURN WOOD	90% UL	% BURNING WOOD	90%UL
1	TELEPHONE	275	87	27.01	31.64	36.56
2	LETTER	53	12	13.61	22.64	34.09
3	VISIT	77	13	10.29	16.88	25.50
4	OTHER	10	0	0.00	0.00	20.57

THIS IS THE SUMMARY OF THE FUTURE PLANS OF THE PEOPLE OF GT. FALLS

OF THE 396.0 PEOPLE THAT ANSWERED QUESTION #16
THERE WERE 26.0 YES ANSWERS,(6.57%)
AND THERE WERE 39.0 MAYBE ANSWERS,(9.85%)
AND THERE WERE 331.0 NO ANSWERS,(83.59%)

OF THE 65 PEOPLE THAT INDICATED THEY WILL (OR MIGHT) BUY A WOOD BURNING DEVICE IN THE NEXT TWO YEARS, THERE WILL BE
5.0 FIREPLACES
31.0 AIRTIGHT WOOD STOVES
19.0 NON-AIRTIGHT WOOD STOVES
1.5 WOOD FURNACES
0.0 COOKSTOVES
2.0 INSERTS ADDED TO WHAT IS PRESENT TODAY

THE FOLLOWING IS THE % INCREASE IN THE PRESENT NUMBER OF DEVICES THAT THIS INCREASE REPRESENTS

DEVICE	PRESENT NUMBER	EXPECTED INCREASE(#)	EXPECTED INCREASE (%)
FIREPLACES	96.0	5.0	5.21
AIRTIGHT WOOD STOVES	42.0	31.0	73.81
NON-AIRTIGHT WOOD STOVES	12.0	10.0	83.33
WOOD FURNACES	2.0	1.5	75.00
COOKSTOVES	0.0	0.0	0.00

THIS IS A SUMMARY OF KALISPEL

OF THE 406 RESIDENCES SURVEYED, 163 BURN WOOD AND 243 DO NOT.

BASED ON THIS, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE PRECENTAGE OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	33.91	40.15	46.64
0.05	35.34	40.15	45.09
0.10	36.08	40.15	44.32
0.15	36.57	40.15	43.81
0.20	36.95	40.15	43.42
0.25	37.26	40.15	43.10

BASED ON A CITY OF 9253 RESIDENCES, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE NUMBER OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	3138.05	3714.87	4315.20
0.05	3270.47	3714.87	4172.55
0.10	3338.94	3714.87	4100.56
0.15	3384.06	3714.87	4053.57
0.20	3418.75	3714.87	4017.57
0.25	3447.78	3714.87	3987.66

OF THE 163 HOMES THAT BURN WOOD,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF WOOD BURNING HOMES	90% LOWER LIMIT
Primary Heat	47.83	41.10	34.62
Auxiliary Heat	42.22	35.58	29.35
Cooking	2.88	0.61	0.03
Enjoyment	24.12	18.40	13.57
No Response		4.294	

OF THE 406 HOMES THAT RESPONDED TO THE QUESTIONNAIRE,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF ALL HOMES	90% LOWER LIMIT
Primary Heat	19.84	16.50	13.54
Auxiliary Heat	17.46	14.29	11.51
Cooking	1.16	0.25	0.01
Enjoyment	9.39	7.39	5.37
No Response		1.724	

BASED ON A CITY SIZE OF 9253 RESIDENCES, THE ABOVE PERCENTAGES CORRESPOND TO THE FOLLOWING NUMBER OF HOMES:

REASON	90% UPPER LIMIT	NUMBER OF HOMES	90% LOWER LIMIT
Primary Heat	1835.37	1526.97	1252.59
Auxiliary Heat	1615.69	1321.86	1064.65
Cooking	107.58	22.79	1.17
Enjoyment	915.16	683.72	496.76
No Response		159.534	

THIS IS A SUMMARY OF KALISPEL 'S SURVEY DATA REGARDING FIREPLACES

OF THE 406 RESPONDENTS TO SURVEY 75 HAVE ONE OR MORE FIREPLACES

THIS CORRESPONDS TO 18.47% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 21.93 : 90% LOWER LIMIT= 15.361)
THERE WERE 3 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 9253 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 1709.3 HOMES. (90% UPPER LIMIT= 2029.3 : 90% LOWER LIMIT= 1421.4)

OF THE 75 PEOPLE WHO HAVE FIREPLACES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	2	0	59	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	3	0	79	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	6	17	12	6	6	6	4	2	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	8	23	16	8	8	8	5	3	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	7	4	0	8	10	15	9	5	0	2	1	1	0	2	0	1	1	0	0	0	0	0	0	0	0	9
% OF HOMES	9	5	0	11	13	20	12	7	0	3	1	1	0	3	0	1	1	0	0	0	0	0	0	0	0	12

BASED ON THE 66 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR FIREPLACES

THE TOTAL DEVICE HOURS PER WEEK= 3050.03 AND THE AVERAGE PER RESIDENCE= 46.213

PRORATING THESE LEVELS TO ALL 75 PEOPLE WHO HAVE FIREPLACES
THE TOTAL DEVICE HOURS PER WEEK= 3465.94

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 15.620 POUNDS OF WOOD PER HOUR)	463.963 TONS OF WOOD BEING BURNED
(BASED ON 1.562 POUNDS OF CO PER HOUR)	46.396 TONS OF CO BEING EMITTED
(BASED ON 0.234 POUNDS OF PARTICULATES PER HOUR)	6.959 TONS OF PARTICULATES BEING EMITTED

BASED ON 9253 HOMES IN THE CITY
THERE ARE 1353906.900 DEVICE HOURS
AND 10574.012 TONS OF WOOD BURNED
AND 1057.401 TONS OF Carbon Monoxide EMITTED
AND 158.610 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF FIREPLACES OVER A HEATING SEASON

THIS IS A SUMMARY OF KALISPEL 'S SURVEY DATA REGARDING AIRTIGHT WOOD STOVES

OF THE 406 RESPONDENTS TO SURVEY 71 HAVE ONE OR MORE AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 17.49% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 20.89 : 90% LOWER LIMIT= 14.446)
THERE WERE 6 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 9253 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 1618.1 HOMES. (90% UPPER LIMIT= 1932.7 : 90% LOWER LIMIT= 1336.9)

OF THE 71 PEOPLE WHO HAVE AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	68	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	96	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	1	2	3	2	4	4	6	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	1	3	4	3	6	6	8	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	5	0	0	5	0	0	2	4	2	4	1	3	2	9	0	1	1	3	0	1	0	2	0	0	0	26
% OF HOMES	7	0	0	7	0	0	3	6	3	6	1	4	3	13	0	1	1	4	0	1	0	3	0	0	0	37

BASED ON THE 66 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 6997.02 AND THE AVERAGE PER RESIDENCE= 106.015

OF THE 64.0 PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
51.563% SAID IT WAS FULLY CLOSED AND 48.438% SAID IT WAS NOT

PRORATING THESE LEVELS TO ALL 71 PEOPLE WHO HAVE AIRTIGHT WOOD STOVES
THE TOTAL DEVICE HOURS PER WEEK= 7527.10

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.675 POUNDS PER HOUR WHEN IT IS CLOSED) 465.721 TONS OF WOOD BEING BURNED

(BASED ON 1.515 POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.810 POUNDS PER HOUR WHEN CLOSED) 72.334 TONS OF CO BEING EMITTED

(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.184 POUNDS PER HOUR WHEN CLOSED) 14.954 TONS OF PARTICULATES BEING EMITTED

BASED ON 9253 HOMES IN THE CITY
THERE ARE 2940321.900 DEVICE HOURS
AND 10614.089 TONS OF WOOD BURNED
AND 1648.534 TONS OF Carbon Monoxide EMITTED
AND 340.812 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF KALISPEL 'S SURVEY DATA REGARDING NON-AIRTIGHT WOOD STOVES

OF THE 406 RESPONDENTS TO SURVEY 25 HAVE ONE OR MORE NON-AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 6.16% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 8.49 : 90% LOWER LIMIT= 4.318)
THERE WERE 6 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 9253 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 569.8 HOMES. (90% UPPER LIMIT= 786.0 : 90% LOWER LIMIT= 399.5)

OF THE 25 PEOPLE WHO HAVE NON-AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	1	0	23	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	4	0	92	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	2	0	5	2	1	0	2	1	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	8	0	20	8	4	0	8	4	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	4	0	0	1	4	1	1	3	0	2	0	1	0	2	0	0	0	0	0	1	0	0	0	0	0	5
% OF HOMES	16	0	0	4	16	4	4	12	0	8	0	4	0	8	0	0	0	0	0	4	0	0	0	0	0	20

BASED ON THE 21 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR NON-AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 1374.00 AND THE AVERAGE PER RESIDENCE= 65.429

OF THE 20.0 PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
65.000% SAID IT WAS FULLY CLOSED AND 35.000% SAID IT WAS NOT

PRORATING THESE LEVELS TO ALL 25 PEOPLE WHO HAVE NON-AIRTIGHT WOOD STOVES
THE TOTAL DEVICE HOURS PER WEEK= 1635.71

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.675 POUNDS PER HOUR WHEN IT IS CLOSED) 95.477 TONS OF WOOD BEING BURNED

(BASED ON 1.515 POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.810 POUNDS PER HOUR WHEN CLOSED) 15.215 TONS OF CO BEING EMITTED

(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.184 POUNDS PER HOUR WHEN CLOSED) 3.172 TONS OF PARTICULATES BEING EMITTED

BASED ON 9253 HOMES IN THE CITY
THERE ARE 638961.660 DEVICE HOURS
AND 2175.990 TONS OF WOOD BURNED
AND 346.769 TONS OF Carbon Monoxide EMITTED
AND 72.293 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF NON-AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF KALISPEL 'S SURVEY DATA REGARDING WOOD FURNACES

OF THE 496 RESPONDENTS TO SURVEY 8 HAVE ONE OR MORE WOOD FURNACES

THIS CORRESPONDS TO 1.97% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 3.53 : 90% LOWER LIMIT= 0.984)
THERE WERE 5 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 9253 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 182.3 HOMES. (90% UPPER LIMIT= 326.4 : 90% LOWER LIMIT= 91.1)

OF THE 8 PEOPLE WHO HAVE WOOD FURNACES
THE FOLLOWING ARE HISTOGRAMS OF:

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	1	0	1	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	12	0	12	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
% OF HOMES	25	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62

BASED ON THE 6 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR WOOD FURNACES

THE TOTAL DEVICE HOURS PER WEEK= 848.00 AND THE AVERAGE PER RESIDENCE= 141.333

PRORATING THESE LEVELS TO ALL 8 PEOPLE WHO HAVE WOOD FURNACES
THE TOTAL DEVICE HOURS PER WEEK= 1130.67

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 29.850 POUNDS OF WOOD PER HOUR)	289.241 TONS OF WOOD BEING BURNED
(BASED ON 0.500 POUNDS OF CO PER HOUR)	4.845 TONS OF CO BEING EMITTED
(BASED ON 0.109 POUNDS OF PARTICULATES PER HOUR)	1.055 TONS OF PARTICULATES BEING EMITTED

BASED ON 9253 HOMES IN THE CITY
THERE ARE 441674.100 DEVICE HOURS
AND 6591.986 TONS OF WOOD BURNED
AND 110.419 TONS OF Carbon Monoxide EMITTED
AND 24.049 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF WOOD FURNACES OVER A HEATING SEASON

THIS IS A SUMMARY OF KALISPEL 'S SURVEY DATA REGARDING COOKSTOVES

OF THE 406 RESPONDENTS TO SURVEY 3 HAVE ONE OR MORE COOKSTOVES

THIS CORRESPONDS TO 0.74% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 1.90 : 90% LOWER LIMIT= 0.202)
THERE WERE 5 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 9253 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 68.4 HOMES. (90% UPPER LIMIT= 175.7 : 90% LOWER LIMIT= 18.7)

OF THE 3 PEOPLE WHO HAVE COOKSTOVES
THE FOLLOWING ARE HISTOGRAMS OF:

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	0	33	33	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
% OF HOMES	33	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0

BASED ON THE 2 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR COOKSTOVES

THE TOTAL DEVICE HOURS PER WEEK= 64.00 AND THE AVERAGE PER RESIDENCE= 32.000

PRORATING THESE LEVELS TO ALL 3 PEOPLE WHO HAVE COOKSTOVES
THE TOTAL DEVICE HOURS PER WEEK= 96.00

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR)	9.625 TONS OF WOOD BEING BURNED
(BASED ON 1.515 POUNDS OF CO PER HOUR)	1.246 TONS OF CO BEING EMITTED
(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR)	0.241 TONS OF PARTICULATES BEING EMITTED

BASED ON 9253 HOMES IN THE CITY
THERE ARE 3750).632 DEVICE HOURS
AND 219.360 TONS OF WOOD BURNED
AND 28.407 TONS OF Carbon Monoxide EMITTED
AND 5.484 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF COOKSTOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF THE TOTAL WOOD USE IN KALISPEL AMONG THE HOMES SURVEYED

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	201.0	90.0	74.0	26.0	8.0	3.0
DEVICE HOURS/WEEK	13355.422	3465.943	7527.097	1635.714	1130.667	96.000
% OF DEVICES		44.8	36.8	12.9	4.0	1.5
% OF DEVICE.HOURS/WEEK		25.0	54.3	11.8	8.2	0.7

BASED ON A CITY SIZE OF 9253 THE ABOVE DATA TRANSLATES INTO THE FOLLOWING # OF DEVICES AND HOURS IN OPERATION PER WEEK

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	9207.6	2051.2	1686.5	592.6	182.3	68.4
DEVICE HOURS/WEEK	43751809.000	78991.065	171547.370	37278.976	25768.617	2187.901

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	OTHER DEVICE= OWNED	N	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
FIREPLACES		73	100.00	13.70	9.59	0.00	0.00
AIRTIGHT WOOD STOVES		71	14.08	100.00	5.63	1.41	1.41
NON-AIRTIGHT WOOD STOVES		25	28.00	16.00	100.00	0.00	4.00
WOOD FURNACES		8	0.00	12.50	0.00	100.00	12.50
COOKSTOVES		3	0.00	33.33	33.33	33.33	100.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES			18.47	17.49	6.16	1.97	0.74

OF THE 163 PEOPLE WHO BURN WOOD, 135 PEOPLE ALSO ESTIMATED HOW MUCH WOOD THEY BURN.
OF THESE 122 ALSO ANSWERED THE QUESTIONNAIRE REGARDING HOW MUCH THEY USE THEIR WOOD BURNING DEVICES

BASED ON THE 135 PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURN, THERE WERE 442.21 CORDS BURNED.
PRORATING THIS TO ALL 163 PEOPLE IN THE SURVEY WHO BURN WOOD, THIS CORRESPONDS TO 533.93 CORDS OF WOOD BURNED.
PRORATING THIS TO ALL 3714.87 HOMES IN THE CITY OF KALISPEL THAT BURN WOOD, THIS EQUALS 12168.55 CORDS OF WOOD.

USING A CONVERSION FACTOR OF 1.680 TONS OF WOOD PER CORD THIS CORRESPONDS TO 20443.169 TONS OF WOOD BURNED IN THE CITY.

BASED ON A CONVERSION FACTOR OF 39.6 POUNDS OF Particulate PER TON OF WOOD BURNED, THE CITY EMITS 405.09 TONS OF PARTICULATE

GIVEN A CONVERSION FACTOR OF 211.5 POUNDS OF Carbon Monoxide PER TON OF WOOD BURNED, THE CITY EMITS 2161.58 TONS OF CO
COMPARE THE ABOVE ESTIMATES WITH THE FOLLOWING ESTIMATES THAT ARE BASED ON THE HOURLY RATES ASSUMED FOR THE VARIOUS DEVICES

THE TOTAL TONS OF WOOD BURNED= 30175.437
THE TOTAL TONS OF CO EMITTED= 3191.529
THE TOTAL TONS OF PARTICULATES= 601.249

THE FOLLOWING IS A SUMMARY OF THE TOTAL WOOD BURNED AND THE CARBON MONOXIDE AND PARTICULATES PRODUCED BY EACH CENSUS TRACT

THE FOLLOWING IS A BREAKDOWN OF THE PERCENTAGES OF HOMES IN EACH CENSUS TRACT THAT BURN WOOD

CENSUS TRACT	HOMES SURVEYED	HOMES BURNING WOOD	% BURNING WOOD	90%UL	90%LL	PROB % = CITY MEAN OF 40.1
1	12	10	83.33	96.96	56.19	0.07
2	31	19	61.29	75.92	44.95	1.06
3	3	0	0.00	53.59	0.00	42.88
4	38	19	50.00	64.26	35.74	16.24
5	17	7	41.18	63.61	21.19	72.85
6	14	9	64.29	84.72	39.05	3.60
7	5	3	60.00	92.36	18.93	17.64
8	32	12	37.50	53.57	23.26	91.00
9	14	2	14.29	38.54	2.60	7.77
10	20	8	40.00	60.64	21.70	81.94
11	24	7	29.17	47.88	14.57	37.59
12	8	4	50.00	80.71	19.29	35.19
13	6	4	66.67	93.72	27.15	8.33
14	24	7	29.17	47.88	14.57	37.59
15	27	6	22.22	39.22	10.15	8.15
16	23	3	13.04	30.37	3.65	0.99
17	24	8	33.33	52.15	17.79	64.52
18	10	7	70.00	91.27	39.34	2.52
19	23	8	34.78	54.05	18.63	76.56
20	34	12	35.29	50.82	21.78	69.53
21	1	1	100.00	100.00	10.01	80.30
22	5	0	0.00	36.91	0.00	15.36
23	3	1	33.33	86.46	1.69	70.83
24	8	6	75.00	95.36	40.03	1.75
ALL	406	163	40.15	44.32	36.08	95.70

THIS IS A BREAKDOWN OF THE WOOD USE AND EMISSIONS OBSERVED IN THE SURVEY FOR EACH CENSUS TRACT
NOTE : THE BELOW TOTALS ARE PRORATED TO ALL THE PEOPLE SURVEYED THAT BURN WOOD IN A GIVEN CENSUS TRACT - c.f. THE ABOVE TABLE

CENSUS TRACT #0 IS THE TOTALS FOR ALL CENSUS TRACTS

NOTE:: n1 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURNED
n2 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MANY HOURS THEY USED THEIR DEVICES

CENSUS TRACT NUMBER	n1	PEOPLE'S ESTIMATE OF WOOD USE (TONS)	n2	DEVICE HOURS ESTIMATE OF WOOD USE (TONS)	CO EMITTED (TONS)	PARTICULATES EMITTED (TONS)
0	135	896.998	122	1411.091	147.477	27.445
1	9	67.200	9	74.496	9.755	1.865
2	15	110.996	15	198.178	19.214	3.581
3	0	0.000	0	0.000	0.000	0.000
4	15	129.808	14	189.368	18.866	3.762
5	4	44.100	3	126.518	5.304	1.082
6	9	39.480	8	59.490	8.504	1.690
7	3	10.500	3	23.639	2.364	0.355
8	10	73.584	10	103.032	12.609	2.284
9	2	6.720	2	4.108	0.729	0.154
10	7	32.160	7	30.031	3.790	0.682
11	6	22.050	4	49.172	5.715	0.974
12	4	39.984	3	117.083	6.959	1.110
13	4	33.600	4	19.623	4.292	0.972
14	6	62.720	5	63.658	7.487	1.292
15	6	25.200	5	38.383	5.546	1.118
16	2	7.560	2	63.403	6.340	0.951
17	7	22.080	7	30.284	3.312	0.550
18	5	36.456	5	40.978	5.437	1.026
19	6	49.280	5	123.401	8.591	1.713
20	10	40.320	9	71.077	8.177	1.419
21	1	8.400	0	0.000	0.000	0.000
22	0	0.000	0	0.000	0.000	0.000
23	1	8.400	0	0.000	0.000	0.000
24	3	23.520	2	14.015	1.579	0.270

BECAUSE THERE ARE NO CENSUS TRACT DATA THE TOTALS CANNOT BE PRORATED TO THE ENTIRE CENSUS TRACT

THE FOLLOWING IS THE REGRESSION LINE OF TOTAL CORDS OF WOOD AS A FUNCTION OF TOTAL DEVICE HOURS/WEEK

PARAMETER	MEAN	STANDARD DEVIATION
TOTAL DEVICE HOURS PER WEEK	85.728	82.562
TOTAL CORDS OF WOOD BURNED	3.198	2.362

CORRELATION BETWEEN THE TWO = 0.6738

THE EQUATION OF THE REGRESSION LINE IS:

TOTAL CORDS USES PER SEASON PER HOUSEHOLD = 0.019 TIMES THE TOTAL DEVICE HOURS PER WEEK IN A HOME PLUS 1.546 CORDS

THE PROBABILITY THAT THE SLOPE OF THE REGRESSION LINE IS ZERO = -0.000
THE % OF THE TOTAL VARIANCE IN TOTAL CORDS OF WOOD USED PER HOME THAT IS EXPLAINED BY THE TOTAL DEVICE HOURS PER HOME= 45.399

THE MEAN # OF CORDS PER HOUSE= 3.20
THE MEAN NUMBER OF DEVICE HOURS PER WEEK PER HOUSE DUE TO

FIREPLACES	=	22.793
AIRTIGHT WOOD STOVES	=	45.943
NON-AIRTIGHT WOOD STOVES	=	9.607
WOOD FURNACES	=	6.951
COOKSTOVES	=	0.525

THE FIVE DIMENSION REGRESSION LINE =
THE # OF CORDS BURNED PER SEASON PER HOUSE HOLD =
0.018 TIMES THE # OF DEVICE HOURS PER WEEK FROM FIREPLACES +
0.021 TIMES THE # OF DEVICE HOURS PER WEEK FROM AIRTIGHT WOOD STOVES +
0.015 TIMES THE # OF DEVICE HOURS PER WEEK FROM NON-AIRTIGHT WOOD STOVES +
0.022 TIMES THE # OF DEVICE HOURS PER WEEK FROM WOOD FURNACES +
-0.016 TIMES THE # OF DEVICE HOURS PER WEEK FROM COOKSTOVES +
PLUS 1.53 CORDS
THE PERCENT OF THE TOTAL VARIATION EXPLAINED BY THIS LINE= 46.594

THIS IS A SUMMARY OF QUESTIONS 12,13 & 14 FOR KALISPEL

:::::::::: QUESTION 12 ::::::

THERE WERE 163 PEOPLE WHO SAID THEY BURN WOOD
OF THE 163 HOMES THAT BURN WOOD, 12. NEGLECTED TO STATE HOW MUCH OF THE WOOD HAS BEEN DEAD FOR AT LEAST 6 MONTHS
CONSEQUENTLY THE FOLLOWING WILL BE BASED ON THE 151 PEOPLE THAT ANSWERED THE QUESTION

THE AMOUNT OF WOOD DEAD FOR AT LEAST 6 MONTHS	NUMBER OF RESPONDENTS	% OF RESPONDENTS
	2.0	1.325
40 - 80 %	10.0	6.623
80 - 100%	139.0	92.053

:::::::::::::: QUESTION 13 ::::::::::

THERE WERE 5.0 INVALID ANSWERS TO THIS QUESTION
OF THE 158 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 115.0 YES ANSWERS (72.78 %) I.E. WOOD IS COVERED
AND 43.0 NO ANSWERS (27.22 %) I.E. WOOD IS NOT COVERED

:::::::::::::::: QUESTIONS 14 & 15 ::::::::::

THERE WERE 6.0 INVALID ANSWERS TO THIS QUESTION
OF THE 157 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 123.0 YES ANSWERS (78.34 %) I.E. WOOD IS EITHER SPLIT OR DIAMETER IS LESS THAN 6"
AND 34.0 NO ANSWERS (21.66 %) I.E. WOOD IS NOT SPLIT AND DIAMETER IS GREATER THAN 6"

OF THE 34.0 PEOPLE THAT DID NOT SPLIT THE WOOD 1.0 DID NOT INDICATE THE LENGTHS OF THE WOOD

OF THE 33 PEOPLE THAT DID INDICATE HOW LONG THE UNCUT OR UNSPLIT WOOD WAS,
THERE WERE 3.0 (9.091%) WHO LEFT IN IN LENGTHS GREATER THAN 3 FEET
AND THERE WERE 30.0 (90.909%) WHO CUT IT SHORTER THAN 3 FEET

THE FOLLOWING IS A BREAKDOWN OF THE % OF HOMES THAT BURN WOOD AS A FUNCTION OF THE INTERVIEW TECHNIQUE USED

THERE WERE 406.0 RESPONSES TO THIS SURVEY

#	TECHNIQUE	# SURVEYED	# BURN WOOD	90% UL	% BURNING WOOD	90%UL
1	TELEPHONE	223	93	36.16	41.70	47.42
2	LETTER	97	44	36.73	45.36	54.21
3	VISIT	86	26	22.13	30.23	39.40
4	OTHER	0	0	0.00	********	100.00

THIS IS THE SUMMARY OF THE FUTURE PLANS OF THE PEOPLE OF KALISPEL

OF THE 373.0 PEOPLE THAT ANSWERED QUESTION #16
THERE WERE 22.0 YES ANSWERS,(5.90%)
AND THERE WERE 40.0 MAYBE ANSWERS,(10.72%)
AND THERE WERE 311.0 NO ANSWERS,(83.38%)

OF THE 62 PEOPLE THAT INDICATED THEY WILL (OR MIGHT) BUY A WOOD BURNING DEVICE IN THE NEXT TWO YEARS, THERE WILL BE
2.0 FIREPLACES
24.5 AIRTIGHT WOOD STOVES
7.5 NON-AIRTIGHT WOOD STOVES
6.5 WOOD FURNACES
1.0 COOKSTOVES
3.5 INSERTS ADDED TO WHAT IS PRESENT TODAY

THE FOLLOWING IS THE % INCREASE IN THE PRESENT NUMBER OF DEVICES THAT THIS INCREASE REPRESENTS

DEVICE	PRESENT NUMBER	EXPECTED INCREASE(#)	EXPECTED INCREASE (%)
FIREPLACES	90.0	2.0	2.22
AIRTIGHT WOOD STOVES	74.0	24.5	33.11
NON-AIRTIGHT WOOD STOVES	26.0	7.5	28.85
WOOD FURNACES	8.0	6.5	81.25
COOKSTOVES	3.0	1.0	33.33

THIS IS A SUMMARY OF HELENA

OF THE 431 RESIDENCES SURVEYED, 145 BURN WOOD AND 286 DO NOT.

BASED ON THIS, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE PRECENTAGE OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	27.86	33.64	39.77
0.05	29.19	33.64	38.32
0.10	29.88	33.64	37.58
0.15	30.32	33.64	37.10
0.20	30.67	33.64	36.73
0.25	30.96	33.64	36.42

BASED ON A CITY OF 15847 RESIDENCES, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE NUMBER OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	4415.03	5331.36	6301.80
0.05	4625.89	5331.36	6072.02
0.10	4734.57	5331.36	5955.21
0.15	4805.51	5331.36	5878.83
0.20	4860.50	5331.36	5820.11
0.25	4906.38	5331.36	5771.65

OF THE 145 HOMES THAT BURN WOOD,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF WOOD BURNING HOMES	90% LOWER LIMIT
Primary Heat	35.07	28.28	22.16
Auxiliary Heat	47.84	40.69	33.83
Cooking	1.58	0.00	0.00
Enjoyment	37.23	30.34	24.07
No Response		0.690	

OF THE 431 HOMES THAT RESPONDED TO THE QUESTIONNAIRE,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF ALL HOMES	90% LOWER LIMIT
Primary Heat	12.17	9.51	7.29
Auxiliary Heat	16.72	13.69	11.04
Cooking	0.53	0.00	0.00
Enjoyment	12.93	10.21	7.90
No Response		0.232	

BASED ON A CITY SIZE OF 15847 RESIDENCES, THE ABOVE PERCENTAGES CORRESPOND TO THE FOLLOWING NUMBER OF HOMES:

REASON	90% UPPER LIMIT	NUMBER OF HOMES	90% LOWER LIMIT
Primary Heat	1928.03	1507.49	1154.54
Auxiliary Heat	2648.91	2169.31	1749.85
Cooking	34.45	0.00	0.00
Enjoyment	2049.43	1617.79	1252.45
No Response		36.768	

THIS IS A SUMMARY OF HELSNA 'S SURVEY DATA REGARDING FIREPLACES

OF THE 431 RESPONDENTS TO SURVEY 83 HAVE ONE OR MORE FIREPLACES

THIS CORRESPONDS TO 19.26% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 22.65 : 90% LOWER LIMIT= 16.183)
THERE WERE 1 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 15847 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 3051.7 HOMES. (90% UPPER LIMIT= 3589.8 : 90% LOWER LIMIT= 2564.5)

OF THE 83 PEOPLE WHO HAVE FIREPLACES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	70	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	84	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	1	28	16	9	9	5	2	2	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	1	34	19	11	11	6	2	2	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	5	2	1	10	18	22	10	6	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	2
% OF HOMES	6	2	1	12	22	27	12	7	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	2

BASED ON THE 78 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR FIREPLACES

THE TOTAL DEVICE HOURS PER WEEK= 1188.82 AND THE AVERAGE PER RESIDENCE= 15.241

PRORATING THESE LEVELS TO ALL 83 PEOPLE WHO HAVE FIREPLACES
THE TOTAL DEVICE HOURS PER WEEK= 1265.03

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 15.620 POUNDS OF WOOD PER HOUR)	169.341 TONS OF WOOD BEING BURNED
(BASED ON 1.562 POUNDS OF CO PER HOUR)	16.934 TONS OF CO BEING EMITTED
(BASED ON 0.234 POUNDS OF PARTICULATES PER HOUR)	2.540 TONS OF PARTICULATES BEING EMITTED

BASED ON 15847 HOMES IN THE CITY
THERE ARE 797223.700 DEVICE HOURS
AND 6226.317 TONS OF WOOD BURNED
AND 622.632 TONS OF Carbon Monoxide EMITTED
AND 93.395 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF FIREPLACES OVER A HEATING SEASON

THIS IS A SUMMARY OF [illegible]'S SURVEY DATA REGARDING AIRTIGHT WOOD STOVES

OF THE 432 RESPONDENTS TO SURVEY 54 HAVE ONE OR MORE AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 12.53% OF THE HOMES SURVEYED. (9.% UPPER LIMIT= 15.46 : 90% LOWER LIMIT= 9.987)
THERE WERE 1 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 15847 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 1985.9 HOMES. (90% UPPER LIMIT= 2449.9 : 90% LOWER LIMIT= 1582.7)

OF THE 54 PEOPLE WHO HAVE AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	50	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	94	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	1	3	2	1	7	3	3	5	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	2	6	4	2	13	6	6	9	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	3	0	0	3	4	3	3	4	2	4	0	1	0	6	0	2	0	3	0	0	0	0	0	0	0	18
% OF HOMES	5	0	0	5	7	5	6	7	3	7	0	2	0	11	0	4	0	6	0	0	0	0	0	0	0	33

BASED ON THE 51 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 4345.5 AND THE AVERAGE PER RESIDENCE= 85.206

OF THE 51.(PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
43.137% SAID IT WAS FULLY CLOSED AND 56.863% SAID IT WAS NOT

PRORATING THESE LEVELS TO ALL 54 PEOPLE WHO HAVE AIRTIGHT WOOD STOVES
THE TOTAL DEVICE HOURS PER WEEK= 4601.12

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.67% POUNDS PER HOUR WHEN IT IS CLOSED) 306.260 TONS OF WOOD BEING BURNED

(BASED ON .651[illegible] POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.81[illegible] POUNDS PER HOUR WHEN CLOSED) 46.112 TONS OF CO BEING EMITTED

(BASED ON 0.29[illegible] POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.1[illegible]4 POUNDS PER HOUR WHEN CLOSED) 9.433 TONS OF PARTICULATES BEING EMITTED

BASED ON 15847 HOMES IN THE CITY
THERE ARE 2899639.1[illegible] DEVICE HOURS
AND 1126[illegible].54[illegible] TONS OF WOOD BURNED
AND 1695.44[illegible] TONS OF Carbon Monoxide EMITTED
AND 346.84[illegible] TONS OF PARTICULATES EMITTED
DUE TO THE OPERATION OF AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF HELENA 'S SURVEY DATA REGARDING NON-AIRTIGHT WOOD STOVES

OF THE 431 RESPONDENTS TO SURVEY 20 HAVE ONE OR MORE NON-AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 4.64% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 6.67 : 90% LOWER LIMIT= 3.096)
THERE WERE 1 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 15847 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 735.4 HOMES. (90% UPPER LIMIT= 1057.3 : 90% LOWER LIMIT= 490.7)

OF THE 20 PEOPLE WHO HAVE NON-AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	1	4	2	6	1	1	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	5	20	10	30	5	5	0	5	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	2	0	0	2	2	4	0	2	0	2	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	1
% OF HOMES	10	0	0	10	10	20	0	10	0	10	0	5	0	20	0	0	0	0	0	0	0	0	0	0	0	5

BASED ON THE 18 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR NON-AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 567.25 AND THE AVERAGE PER RESIDENCE= 31.514

OF THE 16.0 PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
31.250% SAID IT WAS FULLY CLOSED AND 68.750% SAID IT WAS NOT

PRORATING THESE LEVELS TO ALL 20 PEOPLE WHO HAVE NON-AIRTIGHT WOOD STOVES
THE TOTAL DEVICE HOURS PER WEEK= 630.28

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.675 POUNDS PER HOUR WHEN IT IS CLOSED) 43.021 TONS OF WOOD BEING BURNED

(BASED ON 1.515 POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.819 POUNDS PER HOUR WHEN CLOSED) 6.419 TONS OF CO BEING EMITTED

(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.184 POUNDS PER HOUR WHEN CLOSED) 1.307 TONS OF PARTICULATES BEING EMITTED

BASED ON 15847 HOMES IN THE CITY
THERE ARE 397203.679 DEVICE HOURS
AND 1581.783 TONS OF WOOD BURNED
AND 235.709 TONS OF Carbon Monoxide EMITTED
AND 46.744 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF NON-AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF HELENA 'S SURVEY DATA REGARDING WOOD FURNACES

OF THE 431 RESPONDENTS TO SURVEY 2 HAVE ONE OR MORE WOOD FURNACES

THIS CORRESPONDS TO 0.46% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 1.45 : 90% LOWER LIMIT= 0.082)
THERE WERE 1 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 15847 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 73.5 HOMES. (90% UPPER LIMIT= 230.3 : 90% LOWER LIMIT= 13.1)

OF THE 2 PEOPLE WHO HAVE WOOD FURNACES
THE FOLLOWING ARE HISTOGRAMS OF:

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	50	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% OF HOMES	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50

BASED ON THE 1 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR WOOD FURNACES

THE TOTAL DEVICE HOURS PER WEEK= 168.00 AND THE AVERAGE PER RESIDENCE= 168.000

PRORATING THESE LEVELS TO ALL 2 PEOPLE WHO HAVE WOOD FURNACES
THE TOTAL DEVICE HOURS PER WEEK= 336.00

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 29,850 POUNDS OF WOOD PER HOUR)	85.954 TONS OF WOOD BEING BURNED
(BASED ON 0.500 POUNDS OF CO PER HOUR)	1.440 TONS OF CO BEING EMITTED
(BASED ON 0.109 POUNDS OF PARTICULATES PER HOUR)	0.314 TONS OF PARTICULATES BEING EMITTED

BASED ON 15847 HOMES IN THE CITY
THERE ARE 211748.289 DEVICE HOURS
AND 3160.343 TONS OF WOOD BURNED
AND 52.937 TONS OF Carbon Monoxide EMITTED
AND 11.539 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF WOOD FURNACES OVER A HEATING SEASON

THIS IS A SUMMARY OF HELENA 'S SURVEY DATA REGARDING COOKSTOVES

OF THE 431 RESPONDENTS TO SURVEY 3 HAVE ONE OR MORE COOKSTOVES

THIS CORRESPONDS TO 0.70% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 1.79 : 90% LOWER LIMIT= 0.190)
THERE WERE 1 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 15847 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 110.3 HOMES. (90% UPPER LIMIT= 283.4 : 90% LOWER LIMIT= 30.1)

OF THE 3 PEOPLE WHO HAVE COOKSTOVES
THE FOLLOWING ARE HISTOGRAMS OF:

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	33	0	0	0	0	0	0	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	33	0	0	0	0	0	0	0	0	0	33	0	33	0	0	0	0	0	0	0	0	0	0	0	0

BASED ON THE 3 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR COOKSTOVES

THE TOTAL DEVICE HOURS PER WEEK= 154.00 AND THE AVERAGE PER RESIDENCE= 51.333

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR)	15.440 TONS OF WOOD BEING BURNED
(BASED ON 1.515 POUNDS OF CO PER HOUR)	1.999 TONS OF CO BEING EMITTED
(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR)	0.386 TONS OF PARTICULATES BEING EMITTED

BASED ON 15847 HOMES IN THE CITY
THERE ARE 97051.294 DEVICE HOURS
AND 567.702 TONS OF WOOD BURNED
AND 73.516 TONS OF Carbon Monoxide EMITTED
AND 14.194 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF COOKSTOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF THE TOTAL WOOD USE IN HELENA AMONG THE HOMES SURVEYED

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	177.0	97.0	55.0	20.0	2.0	3.0
DEVICE HOURS/WEEK	6986.422	1265.026	4631.118	630.278	336.000	154.000
% OF DEVICES		54.8	31.1	11.3	1.1	1.7
% OF DEVICE HOURS/WEEK		18.1	65.9	9.0	4.8	2.2

BASED ON A CITY SIZE OF 15847 THE ABOVE DATA TRANSLATES INTO THE FOLLOWING # OF DEVICES AND HOURS IN OPERATION PER WEEK

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	11519.0	3566.5	2022.2	735.4	73.5	118.3
DEVICE HOURS/WEEK	17946485.000	46512.467	169173.810	23174.041	12354.042	5662.269

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	OTHER DEVICE=	N OWNED	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
FIREPLACES		83	100.00	10.84	7.23	0.00	2.41
AIRTIGHT WOOD STOVES		54	16.67	100.00	1.85	0.00	0.00
NON-AIRTIGHT WOOD STOVES		20	30.00	5.00	100.00	0.00	0.00
WOOD FURNACES		2	0.00	0.00	0.00	100.00	0.00
COOKSTOVES		3	66.67	0.00	0.00	0.00	100.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES			19.26	12.53	4.64	0.46	0.70

OF THE 145 PEOPLE WHO BURN WOOD, 121 PEOPLE ALSO ESTIMATED HOW MUCH WOOD THEY BURN.
OF THESE 113 ALSO ANSWERED THE QUESTIONNAIRE REGARDING HOW MUCH THEY USE THEIR WOOD BURNING DEVICES

BASED ON THE 121 PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURN, THERE WERE 260.18 CORDS BURNED.
PRORATING THIS TO ALL 145 PEOPLE IN THE SURVEY WHO BURN WOOD, THIS CORRESPONDS TO 311.79 CORDS OF WOOD BURNED.
PRORATING THIS TO ALL 5331.36 HOMES IN THE CITY OF HELENA THAT BURN WOOD, THIS EQUALS 11463.74 CORDS OF WOOD.

USING A CONVERSION FACTOR OF 1.490 TONS OF WOOD PER CORD THIS CORRESPONDS TO 17080.973 TONS OF WOOD BURNED IN THE CITY.

BASED ON A CONVERSION FACTOR OF 44.4 POUNDS OF Particulate PER TON OF WOOD BURNED, THE CITY EMITS 378.86 TONS OF PARTICULATE

GIVEN A CONVERSION FACTOR OF 233.4 POUNDS OF Carbon Monoxide PER TON OF WOOD BURNED, THE CITY EMITS 1993.00 TONS OF CO
COMPARE THE ABOVE ESTIMATES WITH THE FOLLOWING ESTIMATES THAT ARE BASED ON THE HOURLY RATES ASSUMED FOR THE VARIOUS DEVICES

THE TOTAL TONS OF WOOD BURNED= 22796.692
THE TOTAL TONS OF CO EMITTED= 2690.231
THE TOTAL TONS OF PARTICULATES= 514.005

THE FOLLOWING IS A SUMMARY OF THE TOTAL WOOD BURNED AND THE CARBON MONOXIDE AND PARTICULATES PRODUCED BY EACH CENSUS TRACT

THE FOLLOWING IS A BREAKDOWN OF THE PERCENTAGES OF HOMES IN EACH CENSUS TRACT THAT BURN WOOD

CENSUS TRACT	HOMES SURVEYED	HOMES BURNING WOOD	% BURNING WOOD	90%UL	90%LL	PROB % = CITY MEAN OF 33.6
1	53	23	43.40	55.60	31.77	10.37
2	39	7	17.95	31.09	8.74	4.84
3	86	19	22.09	30.71	14.98	2.70
4	80	13	16.25	24.59	9.89	0.08
5	69	31	44.93	55.52	34.67	3.80
6	25	18	72.00	86.05	53.77	0.00
7	10	5	50.00	77.76	22.24	15.96
8	10	3	30.00	60.66	8.73	89.84
9	18	9	50.00	70.87	29.13	9.22
10	3	3	100.00	100.00	46.41	7.62
11	5	2	40.00	81.07	7.64	42.90
12	5	2	40.00	81.07	7.64	42.90
13	13	3	23.08	49.46	6.60	62.79
14	9	3	33.33	65.49	9.78	71.46
16	6	4	66.67	93.72	27.15	3.72
ALL	431	145	33.64	37.58	29.86	95.49

THIS IS A BREAKDOWN OF THE WOOD USE AND EMISSIONS OBSERVED IN THE SURVEY FOR EACH CENSUS TRACT
NOTE : THE BELOW TOTALS ARE PRORATED TO ALL THE PEOPLE SURVEYED THAT BURN WOOD IN A GIVEN CENSUS TRACT - c.f. THE ABOVE TABLE

CENSUS TRACT #0 IS THE TOTALS FOR ALL CENSUS TRACTS

NOTE:: n1 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURNED
n2 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MANY HOURS THEY USED THEIR DEVICES

CENSUS TRACT NUMBER	n1	PEOPLE'S ESTIMATE OF WOOD USE (TONS)	n2	DEVICE HOURS ESTIMATE OF WOOD USE (TONS)	CO EMITTED (TONS)	PARTICULATES EMITTED (TONS)
0	121	464.561	113	593.079	74.075	14.375
1	21	73.191	20	124.794	17.319	3.412
2	6	22.598	5	10.435	1.580	0.323
3	16	41.669	15	102.380	6.626	1.224
4	12	40.031	12	36.753	4.569	0.854
5	26	94.157	25	104.473	14.410	2.804
6	15	62.276	14	76.417	10.596	2.086
7	4	13.038	3	19.055	3.168	0.663
8	2	20.115	2	15.621	1.668	0.270
9	8	30.843	7	44.444	5.524	1.013
10	3	8.940	3	9.562	1.398	0.283
11	0	0.000	0	0.000	0.000	0.000
12	1	11.920	0	0.000	0.000	0.000
13	3	12.292	3	8.013	0.801	0.120
14	2	18.997	2	9.167	1.972	0.444
16	2	14.900	2	15.365	2.807	0.600

THERE ARE 13741.0 HOMES IN ALL THE CENSUS TRACTS. THIS COMPARES WITH 15847 HOMES IN THE CITY

THIS IS A BREAKDOWN OF THE TOTAL WOOD USE AND EMISSIONS BY CENSUS TRACT

NOTE THAT CENSUS TRACT #0 IS THE TOTALS FOR ALL TRACTS

NOTE:: nT = TOTAL NUMBER OF HOMES IN CENSUS TRACT

CENSUS TRACT NUMBER	nT	TOTAL WOOD BURNERS IN TRACT	TOTAL WOOD USE IN TRACT	CO EMITTED (TONS)	PARTICULATES EMITTED (TONS)
0	13741	4622.842	18908.347	2361.645	458.285
1	1024	444.377	2411.115	334.620	65.915
2	1013	181.821	271.050	41.043	8.394
3	2627	580.384	3127.353	202.393	37.388
4	2613	424.612	1200.430	149.250	27.910
5	1823	819.029	2760.208	380.717	74.084
6	1011	727.920	3090.284	428.516	84.370
7	426	213.000	811.752	134.977	28.247
8	573	171.900	895.657	95.592	15.490
9	465	232.500	1148.126	142.710	26.173
10	849	849.000	2705.948	395.658	80.109
11	450	180.000	0.000	0.000	0.000
12	166	66.400	0.000	0.000	0.000
13	264	60.923	162.727	16.273	2.441
14	164	54.667	167.046	35.931	8.099
15	23	0.000	0.000	0.000	0.000

16	250	166.667	640.224	116.966	25.006

THE FOLLOWING IS THE REGRESSION LINE OF TOTAL CORDS OF WOOD AS A FUNCTION OF TOTAL DEVICE HOURS/WEEK

PARAMETER	MEAN	STANDARD DEVIATION
TOTAL DEVICE HOURS PER WEEK	48.299	58.724
TOTAL CORDS OF WOOD BURNED	2.143	1.666

CORRELATION BETWEEN THE TWO = 0.5098

THE EQUATION OF THE REGRESSION LINE IS:

TOTAL CORDS USES PER SEASON PER HOUSEHOLD = 0.014 TIMES THE TOTAL DEVICE HOURS PER WEEK IN A HOME PLUS 1.445 CORDS

THE PROBABILITY THAT THE SLOPE OF THE REGRESSION LINE IS ZERO = 0.000
THE % OF THE TOTAL VARIANCE IN TOTAL CORDS OF WOOD USED PER HOME THAT IS EXPLAINED BY THE TOTAL DEVICE HOURS PER HOME= 25.986

THE MEAN # OF CORDS PER HOUSE= 2.14
THE MEAN NUMBER OF DEVICE HOURS PER WEEK PER HOUSE DUE TO

FIREPLACES	=	6.468
AIRTIGHT WOOD STOVES	=	35.288
NON-AIRTIGHT WOOD STOVES	=	4.312
WOOD FURNACES	=	1.487
COOKSTOVES	=	0.743

THE FIVE DIMENSION REGRESSION LINE =
THE # OF CORDS BURNED PER SEASON PER HOUSE HOLD =
0.039 TIMES THE # OF DEVICE HOURS PER WEEK FROM FIREPLACES +
0.016 TIMES THE # OF DEVICE HOURS PER WEEK FROM AIRTIGHT WOOD STOVES +
0.013 TIMES THE # OF DEVICE HOURS PER WEEK FROM NON-AIRTIGHT WOOD STOVES +
0.007 TIMES THE # OF DEVICE HOURS PER WEEK FROM WOOD FURNACES +
0.015 TIMES THE # OF DEVICE HOURS PER WEEK FROM COOKSTOVES +
PLUS 1.26 CORDS
THE PERCENT OF THE TOTAL VARIATION EXPLAINED BY THIS LINE= 29.842

THIS IS A SUMMARY OF QUESTIONS 12,13 & 14 FOR HELENA

:::::::::: QUESTION 12 ::::::

THERE WERE 145 PEOPLE WHO SAID THEY BURN WOOD
OF THE 145 HOMES THAT BURN WOOD, 9. NEGLECTED TO STATE HOW MUCH OF THE WOOD HAS BEEN DEAD FOR AT LEAST 6 MONTHS
CONSEQUENTLY THE FOLLOWING WILL BE BASED ON THE 136 PEOPLE THAT ANSWERED THE QUESTION

THE AMOUNT OF WOOD DEAD FOR AT LEAST 6 MONTHS	NUMBER OF RESPONDENTS	% OF RESPONDENTS
	1.0	0.735
40 - 80 %	5.0	3.676
80 - 100%	130.0	95.586

::::::::::::: QUESTION 13 ::::::::::

THERE WERE 3.0 INVALID ANSWERS TO THIS QUESTION
OF THE 142 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 85.0 YES ANSWERS (59.86 %) I.E. WOOD IS COVERED
AND 57.0 NO ANSWERS (40.14 %) I.E. WOOD IS NOT COVERED

:::::::::::::::: QUESTIONS 14 & 15 ::::::::::

THERE WERE 3.0 INVALID ANSWERS TO THIS QUESTION
OF THE 142 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 112.0 YES ANSWERS (78.87 %) I.E. WOOD IS EITHER SPLIT OR DIAMETER IS LESS THAN 6"
AND 30.0 NO ANSWERS (21.13 %) I.E. WOOD IS NOT SPLIT AND DIAMETER IS GREATER THAN 6"

OF THE 30 PEOPLE THAT DID INDICATE HOW LONG THE UNCUT OR UNSPLIT WOOD WAS,
THERE WERE 3.0 (10.000%) WHO LEFT IN IN LENGTHS GREATER THAN 3 FEET
AND THERE WERE 27.0 (90.000%) WHO CUT IT SHORTER THAN 3 FEET

THE FOLLOWING IS A BREAKDOWN OF THE % OF HOMES THAT BURN WOOD AS A FUNCTION OF THE INTERVIEW TECHNIQUE USED

THERE WERE 431.0 RESPONSES TO THIS SURVEY

#	TECHNIQUE	# SURVEYED	# BURN WOOD	90% UL	% BURNING WOOD	90%UL
1	TELEPHONE	311	118	33.36	37.94	42.70
2	LETTER	50	13	16.12	26.00	38.12
3	VISIT	68	14	12.90	20.59	30.30
4	OTHER	2	0	0.00	0.00	68.38

THIS IS THE SUMMARY OF THE FUTURE PLANS OF THE PEOPLE OF HELENA

OF THE 413.0 PEOPLE THAT ANSWERED QUESTION #16
THERE WERE 18.0 YES ANSWERS,(4.36%)
AND THERE WERE 39.0 MAYBE ANSWERS,(9.44%)
AND THERE WERE 356.0 NO ANSWERS,(86.20%)

OF THE 57 PEOPLE THAT INDICATED THEY WILL (OR MIGHT) BUY A WOOD BURNING DEVICE IN THE NEXT TWO YEARS, THERE WILL BE
4.5 FIREPLACES
26.0 AIRTIGHT WOOD STOVES
2.5 NON-AIRTIGHT WOOD STOVES
2.5 WOOD FURNACES
0.0 COOKSTOVES
2.5 INSERTS ADDED TO WHAT IS PRESENT TODAY

THE FOLLOWING IS THE % INCREASE IN THE PRESENT NUMBER OF DEVICES THAT THIS INCREASE REPRESENTS

DEVICE	PRESENT NUMBER	EXPECTED INCREASE(#)	EXPECTED INCREASE (%)
FIREPLACES	97.0	4.5	4.64
AIRTIGHT WOOD STOVES	55.0	26.0	47.27
NON-AIRTIGHT WOOD STOVES	20.0	2.5	12.50
WOOD FURNACES	2.0	2.5	125.00
COOKSTOVES	3.0	0.0	0.00

THIS IS A SUMMARY OF BOZEMAN

OF THE 417 RESIDENCES SURVEYED, 134 BURN WOOD AND 283 DO NOT.

BASED ON THIS, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE PRECENTAGE OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	26.36	32.13	38.33
0.05	27.67	32.13	36.85
0.10	28.36	32.13	36.10
0.15	28.80	32.13	35.62
0.20	29.15	32.13	35.25
0.25	29.44	32.13	34.94

BASED ON A CITY OF 10555 RESIDENCES, THE FOLLOWING ARE SELECTED CONFIDENCE LIMITS TO THE NUMBER OF RESIDENCES BURNING WOOD

PROBABILITY LEVEL	LOWER LIMIT	MEAN	UPPER LIMIT
0.01	2782.32	3391.77	4045.84
0.05	2920.60	3391.77	3889.32
0.10	2993.06	3391.77	3810.62
0.15	3040.26	3391.77	3759.47
0.20	3077.11	3391.77	3720.12
0.25	3107.54	3391.77	3687.55

OF THE 134 HOMES THAT BURN WOOD,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF WOOD BURNING HOMES	90% LOWER LIMIT
Primary Heat	32.31	25.37	19.28
Auxiliary Heat	45.48	38.06	31.04
Cooking	1.70	0.00	0.00
Enjoyment	42.43	35.07	28.22
No Response		1.493	

OF THE 417 HOMES THAT RESPONDED TO THE QUESTIONNAIRE,
THE FOLLOWING IS A LIST OF REASONS TO BURN WOOD AND THE PERCENT OF THE HOMES THAT BURN WOOD FOR EACH REASON:

REASON	90% UPPER LIMIT	% OF ALL HOMES	90% LOWER LIMIT
Primary Heat	10.71	8.15	6.06
Auxiliary Heat	15.19	12.23	9.68
Cooking	0.55	0.00	0.00
Enjoyment	14.15	11.27	8.81
No Response		0.480	

BASED ON A CITY SIZE OF 10555 RESIDENCES, THE ABOVE PERCENTAGES CORRESPOND TO THE FOLLOWING NUMBER OF HOMES:

REASON	90% UPPER LIMIT	NUMBER OF HOMES	90% LOWER LIMIT
Primary Heat	1130.12	860.60	639.36
Auxiliary Heat	1603.59	1290.90	1021.44
Cooking	58.14	0.00	0.00
Enjoyment	1493.18	1189.65	930.29
No Response		50.624	

THIS IS A SUMMARY OF BOZEMAN 'S SURVEY DATA REGARDING FIREPLACES

OF THE 417 RESPONDENTS TO SURVEY 88 HAVE ONE OR MORE FIREPLACES

THIS CORRESPONDS TO 21.104 OF THE HOMES SURVEYED. (90% UPPER LIMIT= 24.66 : 90% LOWER LIMIT= 17.857)
THERE WERE 2 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 10555 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 2227.4 HOMES. (90% UPPER LIMIT= 2602.5 : 90% LOWER LIMIT= 1884.8)

OF THE 88 PEOPLE WHO HAVE FIREPLACES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	73	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	83	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	1	23	20	16	12	4	2	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	1	26	23	18	14	5	2	2	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	1	3	1	12	13	21	15	12	2	3	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	3
% OF HOMES	1	3	1	14	15	24	17	14	2	3	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	3

BASED ON THE 87 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR FIREPLACES

THE TOTAL DEVICE HOURS PER WEEK= 1429.00 AND THE AVERAGE PER RESIDENCE= 16.425

PRORATING THESE LEVELS TO ALL 88 PEOPLE WHO HAVE FIREPLACES
THE TOTAL DEVICE HOURS PER WEEK= 1445.43

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 15.620 POUNDS OF WOOD PER HOUR)	193.490 TONS OF WOOD BEING BURNED
(BASED ON 1.562 POUNDS OF CO PER HOUR)	19.349 TONS OF CO BEING EMITTED
(BASED ON 0.234 POUNDS OF PARTICULATES PER HOUR)	2.902 TONS OF PARTICULATES BEING EMITTED

BASED ON 10555 HOMES IN THE CITY
THERE ARE 627088.230 DEVICE HOURS
AND 4897.559 TONS OF WOOD BURNED
AND 489.756 TONS OF Carbon Monoxide EMITTED
AND 73.463 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF FIREPLACES OVER A HEATING SEASON

THIS IS A SUMMARY OF BOZEMAN 'S SURVEY DATA REGARDING AIRTIGHT WOOD STOVES

OF THE 417 RESPONDENTS TO SURVEY 33 HAVE ONE OR MORE AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 7.91% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 10.44 : 90% LOWER LIMIT= 5.848)
THERE WERE 2 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 10555 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 835.3 HOMES. (90% UPPER LIMIT= 1102.0 : 90% LOWER LIMIT= 617.3)

OF THE 33 PEOPLE WHO HAVE AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	32	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	97	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	3	0	1	0	0	3	2	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	9	0	3	0	0	9	6	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	0	0	0	2	0	2	1	2	0	3	0	1	0	3	0	2	0	0	0	1	0	1	0	0	0	15
% OF HOMES	0	0	0	6	0	6	3	6	0	9	0	3	0	9	0	6	0	0	0	3	0	3	0	0	0	45

BASED ON THE 33 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 3620.50 AND THE AVERAGE PER RESIDENCE= 109.712

OF THE 33.0 PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
48.485% SAID IT WAS FULLY CLOSED AND 51.515% SAID IT WAS NOT

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.675 POUNDS PER HOUR WHEN IT IS CLOSED) 231.719 TONS OF WOOD BEING BURNED

(BASED ON 1.515 POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.810 POUNDS PER HOUR WHEN CLOSED) 35.470 TONS OF CO BEING EMITTED

(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.184 POUNDS PER HOUR WHEN CLOSED) 7.297 TONS OF PARTICULATES BEING EMITTED

BASED ON 10555 HOMES IN THE CITY
THERE ARE 1576730.100 DEVICE HOURS
AND 5865.219 TONS OF WOOD BURNED
AND 897.802 TONS OF Carbon Monoxide EMITTED
AND 184.706 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF BOZEMAN 'S SURVEY DATA REGARDING NON-AIRTIGHT WOOD STOVES

OF THE 417 RESPONDENTS TO SURVEY 26 HAVE ONE OR MORE NON-AIRTIGHT WOOD STOVES

THIS CORRESPONDS TO 6.24% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 8.55 : 90% LOWER LIMIT= 4.405)
THERE WERE 2 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 10555 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 658.1 HOMES. (90% UPPER LIMIT= 902.1 : 90% LOWER LIMIT= 465.0)

OF THE 26 PEOPLE WHO HAVE NON-AIRTIGHT WOOD STOVES
THE FOLLOWING ARE HISTOGRAMS OF:

NOTE: IF ANY ONE DID NOT INDICATE HOW MANY DEVICES THEY HAVE, IT IS ASSUMED TO BE 1 FOR LATER COMPUTATIONS

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
# OF DEVICES PER HOME	0	0	25	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	96	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	2	1	1	5	1	2	3	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	8	4	4	19	4	8	12	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	0	1	0	1	0	7	2	2	0	4	1	3	0	1	0	0	0	0	0	0	0	1	0	0	0	3
% OF HOMES	0	4	0	4	0	27	8	8	0	15	4	12	0	4	0	0	0	0	0	0	0	4	0	0	0	12

BASED ON THE 26 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR NON-AIRTIGHT WOOD STOVES

THE TOTAL DEVICE HOURS PER WEEK= 1355.5 AND THE AVERAGE PER RESIDENCE= 52.135

OF THE 24.0 PEOPLE THAT INDICATED THE POSITION OF THE DAMPER:
24.[illegible]% SAID IT WAS FULLY CLOSED AND 75.833% SAID IT WAS NOT

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR WHEN DAMPER IS OPEN
AND 3.[illegible] POUNDS PER HOUR WHEN IT IS CLOSED) [illegible] TONS OF WOOD BEING BURNED

(BASED ON 1.515 POUNDS OF CO PER HOUR WITH DAMPER OPEN
AND 0.810 POUNDS PER HOUR WHEN CLOSED) 14.686 TONS OF CO BEING EMITTED

(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR WITH DAMPER OPEN
AND 0.184 POUNDS PER HOUR WHEN CLOSED) 2.949 TONS OF PARTICULATES BEING EMITTED

BASED ON 10555 HOMES IN THE CITY
THERE ARE 688674.7[illegible] DEVICE HOURS
AND 2600.984 TONS OF WOOD BURNED
AND 371.734 TONS OF Carbon Monoxide EMITTED
AND 74.641 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF NON-AIRTIGHT WOOD STOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF BOZEMAN 'S SURVEY DATA REGARDING WOOD FURNACES

OF THE 417 RESPONDENTS TO SURVEY 1 HAVE ONE OR MORE WOOD FURNACES

THIS CORRESPONDS TO 0.24% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 1.13 : 90% LOWER LIMIT= 0.012)
THERE WERE 2 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 10555 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 25.3 HOMES. (90% UPPER LIMIT= 119.5 : 90% LOWER LIMIT= 1.3)

OF THE 1 PEOPLE WHO HAVE WOOD FURNACES
THE FOLLOWING ARE HISTOGRAMS OF:

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BASED ON THE 1 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR WOOD FURNACES

THE TOTAL DEVICE HOURS PER WEEK= 5.00 AND THE AVERAGE PER RESIDENCE= 5.000

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 29.859 POUNDS OF WOOD PER HOUR)	1.279 TONS OF WOOD BEING BURNED
(BASED ON 0.500 POUNDS OF CO PER HOUR)	0.021 TONS OF CO BEING EMITTED
(BASED ON 0.109 POUNDS OF PARTICULATES PER HOUR)	0.005 TONS OF PARTICULATES BEING EMITTED

BASED ON 10555 HOMES IN THE CITY
THERE ARE 2169.217 DEVICE HOURS
AND 32.376 TONS OF WOOD BURNED
AND 0.542 TONS OF Carbon Monoxide EMITTED
AND 0.118 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF WOOD FURNACES OVER A HEATING SEASON

THIS IS A SUMMARY OF BOZEMAN 'S SURVEY DATA REGARDING COOKSTOVES

OF THE 417 RESPONDENTS TO SURVEY 1 HAVE ONE OR MORE COOKSTOVES

THIS CORRESPONDS TO 0.24% OF THE HOMES SURVEYED. (90% UPPER LIMIT= 1.13 : 90% LOWER LIMIT= 0.012)
THERE WERE 2 INVALID RESPONSES TO THIS QUESTION.

BASED ON A CITY SIZE OF 10555 HOMES,
THE ABOVE PERCENTAGES REPRESENTS 25.3 HOMES. (90% UPPER LIMIT= 119.5 : 90% LOWER LIMIT= 1.3)

OF THE 1 PEOPLE WHO HAVE COOKSTOVES
THE FOLLOWING ARE HISTOGRAMS OF:

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DAYS / WEEK IN USE	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARAMETER	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOURS / DAY IN USE	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% OF HOMES	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BASED ON THE 1 COMPLETE ANSWERS REGARDING THE AMOUNT OF TIME THAT PEOPLE USE THEIR COOKSTOVES

THE TOTAL DEVICE HOURS PER WEEK= 35.00 AND THE AVERAGE PER RESIDENCE= 35.000

DURING A HEATING SEASON OF 17.1 WEEKS THE ABOVE WEEKLY AVERAGES RESULT IN:

(BASED ON 11.699 POUNDS OF WOOD PER HOUR)	3.599 TONS OF WOOD BEING BURNED
(BASED ON 1.515 POUNDS OF CO PER HOUR)	0.454 TONS OF CO BEING EMITTED
(BASED ON 0.293 POUNDS OF PARTICULATES PER HOUR)	0.088 TONS OF PARTICULATES BEING EMITTED

BASED ON 10555 HOMES IN THE CITY
THERE ARE 15184.519 DEVICE HOURS
AND 88.822 TONS OF WOOD BURNED
AND 11.502 TONS OF Carbon Monoxide EMITTED
AND 2.221 TONS OF PARTICULATE EMITTED
DUE TO THE OPERATION OF COOKSTOVES OVER A HEATING SEASON

THIS IS A SUMMARY OF THE TOTAL WOOD USE IN BOZEMAN AMONG THE HOMES SURVEYED

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	166.[illegible]	103.0	34.[illegible]	27.0	1.0	1.0
DEVICE HOURS/WEEK	6461.425	1445.425	3620.500	1355.500	5.000	35.000
% OF DEVICES		62.0	20.5	16.3	0.6	0.6
% OF DEVICE HOURS/WEEK		22.4	56.0	21.[illegible]	0.1	0.5

BASED ON A CITY SIZE OF 10555 THE ABOVE DATA TRANSLATES INTO THE FOLLOWING # OF DEVICES AND HOURS IN OPERATION PER WEEK

BREAKDOWN BY DEVICE TYPE

DEVICE=	TOTAL DEVICES	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
# OF DEVICES	6974.9	2607.1	860.6	683.4	25.3	25.3
DEVICE HOURS/WEEK	10567660.000	36586.245	91641.193	34310.078	126.559	885.911

THE FOLLOWING IS A CROSS REFERENCE OF THE % OF HOMES THAT HAVE VARIOUS OTHER DEVICES GIVEN THE FACT THAT THEY **ALSO** HAVE AT LEAST ONE OF A SPECIFIED KIND OF DEVICE

OF THE PEOPLE WHO OWN AT LEAST ONE OF THE BELOW DEVICES	OTHER DEVICE= OWNED	FIRE PLACES	AIR TIGHT WOOD STOVES	NON AIR TIGHT WOOD STOVES	WOOD FURNACES	COOK STOVES
	N					
FIREPLACES	88	100.00	9.09	7.95	1.14	0.00
AIRTIGHT WOOD STOVES	33	24.24	100.00	0.00	0.00	3.03
NON-AIRTIGHT WOOD STOVES	26	26.92	0.00	100.00	0.00	0.00
WOOD FURNACES	1	100.00	0.00	0.00	100.00	0.00
COOKSTOVES	1	0.00	100.00	0.00	0.00	100.00
THESE PERCENTAGES SHOULD BE COMPARED WITH THE FOLLOWING POPULATION WIDE PERCENTAGES		21.10	7.91	6.24	0.24	0.24

OF THE 134 PEOPLE WHO BURN WOOD, 120 PEOPLE ALSO ESTIMATED HOW MUCH WOOD THEY BURN.
OF THESE 120 ALSO ANSWERED THE QUESTIONNAIRE REGARDING HOW MUCH THEY USE THEIR WOOD BURNING DEVICES

BASED ON THE 120 PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURN, THERE WERE 270.98 CORDS BURNED.
PRORATING THIS TO ALL 134 PEOPLE IN THE SURVEY WHO BURN WOOD, THIS CORRESPONDS TO 302.59 CORDS OF WOOD BURNED.
PRORATING THIS TO ALL 3391.77 HOMES IN THE CITY OF BOZEMAN THAT BURN WOOD, THIS EQUALS 7659.05 CORDS OF WOOD.

USING A CONVERSION FACTOR OF 1.450 TONS OF WOOD PER CORD THIS CORRESPONDS TO 11105.624 TONS OF WOOD BURNED IN THE CITY.

BASED ON A CONVERSION FACTOR OF 49.0 POUNDS OF Particulate PER TON OF WOOD BURNED, THE CITY EMITS 272.30 TONS OF PARTICULATE

GIVEN A CONVERSION FACTOR OF 260.6 POUNDS OF Carbon Monoxide PER TON OF WOOD BURNED, THE CITY EMITS 1447.07 TONS OF CO
COMPARE THE ABOVE ESTIMATES WITH THE FOLLOWING ESTIMATES THAT ARE BASED ON THE HOURLY RATES ASSUMED FOR THE VARIOUS DEVICES

THE TOTAL TONS OF WOOD BURNED= 13484.959
THE TOTAL TONS OF CO EMITTED= 1771.336
THE TOTAL TONS OF PARTICULATES= 335.149

THE FOLLOWING IS A SUMMARY OF THE TOTAL WOOD BURNED AND THE CARBON MONOXIDE AND PARTICULATES PRODUCED BY EACH CENSUS TRACT

THE FOLLOWING IS A BREAKDOWN OF THE PERCENTAGES OF HOMES IN EACH CENSUS TRACT THAT BURN WOOD

CENSUS TRACT	HOMES SURVEYED	HOMES BURNING WOOD	% BURNING WOOD	90%UL	90%LL	PROB % = CITY MEAN OF 32.1
1	111	30	27.03	34.83	20.17	29.27
2	105	26	24.76	32.66	17.97	12.55
3	60	17	28.33	39.42	18.93	63.19
4	88	30	34.09	43.29	25.72	60.52
5	12	8	66.67	87.71	39.10	0.58
6	3	1	33.33	86.46	1.69	48.68
7	2	2	100.00	100.00	31.62	20.65
8	18	11	61.11	80.10	39.21	0.55
9	4	3	75.00	98.72	24.87	2.13
10	12	5	41.67	68.47	18.11	30.92
17	1	0	0.00	89.99	0.00	64.27
ALL	416	133	31.97	35.94	28.19	99.00

THERE WERE 1.0 INVALID CENSUS TRACT NUMBERS FOUND

THIS IS A BREAKDOWN OF THE WOOD USE AND EMISSIONS OBSERVED IN THE SURVEY FOR EACH CENSUS TRACT
NOTE : THE BELOW TOTALS ARE PRORATED TO ALL THE PEOPLE SURVEYED THAT BURN WOOD IN A GIVEN CENSUS TRACT - c.f. THE ABOVE TABLE

CENSUS TRACT #0 IS THE TOTALS FOR ALL CENSUS TRACTS

NOTE:: n1 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MUCH WOOD THEY BURNED
n2 = THE NUMBER OF PEOPLE WHO ESTIMATED HOW MANY HOURS THEY USED THEIR DEVICES

CENSUS TRACT NUMBER	n1	PEOPLE'S ESTIMATE OF WOOD USE (TONS)	n2	DEVICE HOURS ESTIMATE OF WOOD USE (TONS)	CO EMITTED (TONS)	PARTICULATES EMITTED (TONS)
0	119	436.222	119	592.413	76.174	14.302
1	30	107.373	30	136.865	18.166	3.453
2	20	70.216	20	110.642	12.428	2.150
3	15	50.122	15	43.744	5.957	1.158
4	27	59.410	27	77.560	3.915	1.551
5	8	39.875	8	62.749	7.942	1.458
6	1	4.350	1	0.801	0.080	0.012
7	2	13.050	2	27.362	4.503	0.948
8	8	37.881	8	39.314	5.683	1.138
9	3	29.725	3	48.280	6.233	1.200
10	5	16.675	5	31.953	4.259	0.825
17	0	0.000	0	0.000	0.000	0.000

BECAUSE THERE ARE NO CENSUS TRACT DATA THE TOTALS CANNOT BE PRORATED TO THE ENTIRE CENSUS TRACT

THE FOLLOWING IS THE REGRESSION LINE OF TOTAL CORDS OF WOOD AS A FUNCTION OF TOTAL DEVICE HOURS/WEEK

PARAMETER	MEAN	STANDARD DEVIATION
TOTAL DEVICE HOURS PER WEEK	50.373	64.534
TOTAL CORDS OF WOOD BURNED	2.258	1.988

CORRELATION BETWEEN THE TWO = 0.7039

THE EQUATION OF THE REGRESSION LINE IS:

TOTAL CORDS USES PER SEASON PER HOUSEHOLD = 0.022 TIMES THE TOTAL DEVICE HOURS PER WEEK IN A HOME PLUS 1.166 CORDS

THE PROBABILITY THAT THE SLOPE OF THE REGRESSION LINE IS ZERO = 0.000
THE % OF THE TOTAL VARIANCE IN TOTAL CORDS OF WOOD USED PER HOME THAT IS EXPLAINED BY THE TOTAL DEVICE HOURS PER HOME= 49.549

THE MEAN # OF CORDS PER HOUSE= 2.26
THE MEAN NUMBER OF DEVICE HOURS PER WEEK PER HOUSE DUE TO

FIREPLACES	=	11.281
AIRTIGHT WOOD STOVES	=	28.563
NON-AIRTIGHT WOOD STOVES	=	10.196
WOOD FURNACES	=	0.042
COOKSTOVES	=	0.292

THE FIVE DIMENSION REGRESSION LINE =
THE # OF CORDS BURNED PER SEASON PER HOUSE HOLD =
0.033 TIMES THE # OF DEVICE HOURS PER WEEK FROM FIREPLACES +
0.021 TIMES THE # OF DEVICE HOURS PER WEEK FROM AIRTIGHT WOOD STOVES +
0.021 TIMES THE # OF DEVICE HOURS PER WEEK FROM NON-AIRTIGHT WOOD STOVES +
-0.183 TIMES THE # OF DEVICE HOURS PER WEEK FROM WOOD FURNACES +
0.005 TIMES THE # OF DEVICE HOURS PER WEEK FROM COOKSTOVES +
PLUS 1.09 CORDS
THE PERCENT OF THE TOTAL VARIATION EXPLAINED BY THIS LINE= 52.420

THIS IS A SUMMARY OF QUESTIONS 12,13 & 14 FOR BOZEMAN

:::::::::: QUESTION 12 ::::::

THERE WERE 134 PEOPLE WHO SAID THEY BURN WOOD
OF THE 134 HOMES THAT BURN WOOD, 9. NEGLECTED TO STATE HOW MUCH OF THE WOOD HAS BEEN DEAD FOR AT LEAST 6 MONTHS
CONSEQUENTLY THE FOLLOWING WILL BE BASED ON THE 125 PEOPLE THAT ANSWERED THE QUESTION

THE AMOUNT OF WOOD DEAD FOR AT LEAST 6 MONTHS	NUMBER OF RESPONDENTS	% OF RESPONDENTS
	0.0	0.000
40 - 80 %	3.0	2.400
80 - 100%	122.0	97.600

:::::::::::::: QUESTION 13 ::::::::::

THERE WERE 3.0 INVALID ANSWERS TO THIS QUESTION
OF THE 131 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 97.0 YES ANSWERS (74.05 %) I.E. WOOD IS COVERED
AND 34.0 NO ANSWERS (25.95 %) I.E. WOOD IS NOT COVERED

:::::::::::::::: QUESTIONS 14 & 15 ::::::::::

THERE WERE 2.0 INVALID ANSWERS TO THIS QUESTION
OF THE 132 PEOPLE THAT ANSWERED THE QUESTION
THERE WERE 106.0 YES ANSWERS (80.30 %) I.E. WOOD IS EITHER SPLIT OR DIAMETER IS LESS THAN 6"
AND 26.0 NO ANSWERS (19.70 %) I.E. WOOD IS NOT SPLIT AND DIAMETER IS GREATER THAN 6"

OF THE 26 PEOPLE THAT DID INDICATE HOW LONG THE UNCUT OR UNSPLIT WOOD WAS,
THERE WERE 1.0 (3.846%) WHO LEFT IN IN LENGTHS GREATER THAN 3 FEET
AND THERE WERE 25.0 (96.154%) WHO CUT IT SHORTER THAN 3 FEET

THE FOLLOWING IS A BREAKDOWN OF THE % OF HOMES THAT BURN WOOD AS A FUNCTION OF THE INTERVIEW TECHNIQUE USED

THERE WERE 417.0 RESPONSES TO THIS SURVEY

#	TECHNIQUE	# SURVEYED	# BURN WOOD	90% UL	% BURNING WOOD	90%UL
1	TELEPHONE	275	103	32.59	37.45	42.52
2	LETTER	76	18	15.90	23.68	33.07
3	VISIT	65	13	12.06	19.70	29.48
4	OTHER	0	0	0.00	********	100.00

THIS IS THE SUMMARY OF THE FUTURE PLANS OF THE PEOPLE OF BOZEMAN

OF THE 398.0 PEOPLE THAT ANSWERED QUESTION #16
THERE WERE 18.0 YES ANSWERS,(4.52%)
AND THERE WERE 36.0 MAYBE ANSWERS,(9.05%)
AND THERE WERE 344.0 NO ANSWERS,(86.43%)

OF THE 54 PEOPLE THAT INDICATED THEY WILL (OR MIGHT) BUY A WOOD BURNING DEVICE IN THE NEXT TWO YEARS, THERE WILL BE
3.5 FIREPLACES
21.5 AIRTIGHT WOOD STOVES
4.5 NON-AIRTIGHT WOOD STOVES
1.5 WOOD FURNACES
0.5 COOKSTOVES
6.0 INSERTS ADDED TO WHAT IS PRESENT TODAY

THE FOLLOWING IS THE % INCREASE IN THE PRESENT NUMBER OF DEVICES THAT THIS INCREASE REPRESENTS

DEVICE	PRESENT NUMBER	EXPECTED INCREASE(#)	EXPECTED INCREASE (%)
FIREPLACES	103.0	3.5	3.40
AIRTIGHT WOOD STOVES	34.0	21.5	63.24
NON-AIRTIGHT WOOD STOVES	27.0	4.5	16.67
WOOD FURNACES	1.0	1.5	150.00
COOKSTOVES	1.0	0.5	50.00

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